Railway Age

DAILY EDITION

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Electric Rolling Stock Report

THE report of the committee on electric rolling stock is remarkable for the amount of useful information contained in it, which, incidentally, is relatively brief as compared with some of the previous compilations on this subject. The standard method of rating electric locomotives which is included in the report fills a real need. The information made available on regenerative braking shows clearly, on the basis of experience, what can be expected from this feature of electric motive power. That part of the report which deals with heating apparatus for passenger trains provides a thorough compilation of railroad experience and clearly shows how this requirement can be satisfactorily supplied. Information on new locomotion is covered by brief and well assimilated data. Comments included in the report which should not be overlooked are those which concern the manner in which the improvement of the steam locomotive, has created new requirements for electrification and the means which are being employed to meet these demands. There was no discussion, but this was to be expected because of the nature of the report. It contains little or nothing which is controversial and much of value to those who will study it and use it to serve their own needs.

Oil Engines

OIL engines as applied to switching locomotives have been making rapid strides during the last few years. They are also available for rail motor cars and for the operation of buses and trucks. All of these applications are on exhibit at the convention. The fundamental economy of the oil engine using a non-volatile fuel and its inherent simplicity have never been seriously questioned. It remained to develop its reliability, to work out the details of its application and establish adequate standards of inspection and maintenance. During the past five years the gasoline engines used for rail motor cars have steadily increased in size. The essential purpose of the cars is to effect operating economies, and as the size of power plants increases the matter of fuel cost becomes of increasing importance. With a continuation of the present trend toward larger units, and assuming that the manufacturers and the maintainers continue to perfect the quality of product and of maintenance, much more extensive applications of oil engines are apparently assured.

Little Things Count In Terminal Operation

ANDREW CARNEGIE is said to have been willing to concur in the policy of any man who concerned himself only with the main issues in life, overlooking little things that do not count, provided that man would state which were the little and unimportant things. Mr. Carnegie's own success, like that of many other great executives, hinged many times on small happenings that had a vital influence upon his entire subsequent career. Applying this principle of the importance of little things to the design of new shop and terminal facilities, it would not be difficult to find numerous instances of impaired effectiveness occasioned by the omission of minor or auxiliary equipment generally relegated to the background as minor details.

One of the most notable examples of this is seen in the frequent failure to provide a few metering and recording instruments which would afford a key to the efficient operation of machinery representing an investment many times the cost of these instruments. How many stationary boilers are being operated by the railroads today without the slightest knowledge of the steam output in relation to the fuel consumed? How many large compressors are running to capacity without any indication of the quantity of air being utilized for various purposes, or dissipated in leakages or wasteful practice? Many thousands of dollars have been spent for equipment to provide hot water for washing and filling

locomotives at terminals, with no means available for obtaining a record of these temperatures. The practice of steaming locomotives in the enginehouse by connection to high-pressure stationary boilers places an additional responsibility upon the railways for providing sufficient indicating and recording apparatus to insure the best results from these large investments in modern terminal equipment.

Co-operation with the A. R. E. E.

TEN progress reports were presented at the meeting of the Association of Railway Electrical Engineers held at the Hotel Dennis on Monday of this week. Several of these covered their respective subjects in considerable detail. These subjects include the every-day working problems that confront the electrical departments. No attempt is made by this association to deal with electrification.

The report of the A. R. A. Mechanical Division Committee on Locomotive and Car Lighting was presented on Tuesday. This report is essentially the same as that presented to the A. R. E. E., indicating close co-operation between the two groups. The Mechanical Division meeting was attended by a large number of members of the A. R. E. E. and Chairman Smart extended the courtesy of the floor to them, thus assuring that any questions asked by the Mechanical Division members would be satisfactorily answered by men intimately familiar with the details of the subject. The relationship between the two bodies is unofficial, but is extremely effective. The electrical problems are studied by men to whom they are vital and the Mechanical Division receives the results of these studies for appliation to the general problems of the mechanical department—a form of co-operation that is much to be desired.

Railway Club Possibilities

THERE are a number of large railway clubs in this country. They differ as to programs and practices in accordance with the conditions which exist in their respective regions and also, of course, with the different personalities or combinations of personalities involved, and their special interests. During the course of a year each one of these clubs does a certain amount of experimenting in trying to improve its program or be of greater practical helpfulness to its members. An effort was made several years ago to stimulate the exchange of ideas and experiences between the clubs through the formation of the Association of Railway Club Secretaries. Certain results were apparent from this organization, but possibly not nearly so great as had been anticipated. The organization has now decided to tackle the problem in a different way and gives greater promise of being a constructive and helpful force.

It must be remembered, also, that in a less formal way there has been a more or less steady interchange of ideas between some of the clubs through visitation back and forth of officers and committee members. Direct results can be traced to some of these exchanges of visits. It is not out of place here to discuss the matter since there is no question but what these clubs offer a splendid opportunity for training men to participate in their club activities and to speak at their meetings, and thus qualify them for doing constructive work in the various divisions of the American Railway Association, or in other national railroad organizations with which they may eventually affiliate.

For instance, studying men, who have been real leaders in the American Railway Master Mechanics' Association, Master Car Builders' Association, and their successor, the Mechanical Division, not a few can be pointed out, who possibly never would have made good in those positions had they not first had the opportunity of developing their talents in the different railroad clubs or minor associations.

It must be remembered also that in promoting the work of the railroad clubs and the various organizations, it is unsafe to settle contentedly into any one type of program or any fixed practices. Conditions in these days change constantly and sometimes very rapidly, and if a club or association is to continue to make good, it must keep everlastingly on the alert to adapt its programs and practices to the needs of its members. May it not be possible, therefore, for the Association of Railway Club Secretaries, in its new program which was decided upon last week in Atlantic City, to become a greater constructive force and help in the interests of the railway clubs of this country—and not alone to those of greater prominence, but also to others that are less widely known and recognized?

Record Attendance of Railway Officers

THE registration of railway officers this year at the Mechanical and Purchases and Stores conventions has been the largest in history. This is a fact of great significance. Because of the prevailing depression in business it was anticipated by most persons that the attendance of railway officers would be reduced. What is the explanation of the record breaking attendance of railway officers?

It is an indication of the attitude of railway executives toward improvements in all parts of the railway plant. The greatest need of the railways at present is not for enlargement of their capacity, but for physical improvements which will enable them to effect economies by reducing the amount of labor, materials and fuel used. The pressure for economies in operation has become so great because traffic and total earnings are not increasing as fast as they did before the war, and it is mainly through economies in operation that the railways must seek to maintain or increase their net operating income.

Railway executives are well aware that the largest economies are obtainable through improvements in the physical plants, and the large attendance of railway officers at the conventions is so significant because it shows that railway executives realize that mechanical and other officers can, in a given time, acquaint themselves with more economy-producing devices by looking over the

exhibit of the equipment and supply manufacturers, than in any other way.

Recognition of this fact is not confined to railway officers. Frank McManamy, chairman of the Interstate Commerce Commission, has been attending the conventions and inspecting the exhibits for many years. In his address on Monday, Mr. McManamy recalled that eleven years ago it became his duty to determine for the United States Railroad Administration whether the conventions of the Mechanical Division should be held. "I decided then that they did pay," said Mr. McManamy, "and have had no occasion since to change my mind." His remarks showed that he had in mind not only the sessions of the convention, but also the opportunities afforded by the exhibit to railway officers within a few days to inform themselves regarding so many improvements in equipment and devices.

It has often been said that the conventions and exhibit have been a success because there has been a large attendance. The real measure of their success is not what occurs in Atlantic City, but the use that is made later of the information acquired here. As Mr. McManamy said to the mechanical officers, "If you take advantage of the opportunities here afforded to improve your knowledge of railway appliances and methods, it will return substantial dividends." The effects of the conventions and the exhibit in promoting efficiency and economy of railway operations are cumulative over the years, and the railways in no small measure owe their present efficiency and economy of operation to the conventions and exhibits of the past. No better evidence that the spirit of progress is just as much alive as it ever was in the railroad industry could be afforded than is afforded by the conventions and exhibit of 1930.

Lessons from Europe

THE railways of this continent have profited greatly in the past from European locomotive designs and practices, although in many instances these things have been introduced and adapted in this country through the initiative of the railway supply interests. Just a little less than thirty years ago a group of railroad and railway supply men induced the late George M. Basford to visit Europe on their behalf, in order to study European mechanical department practices. His impressions carefully compiled and presented, created much interest at that time. Probably at no period, however, have more mechanical department officers gone abroad than during the past few years and, incidentally, some of the railway supply representatives have almost become trans-Atlantic commuters—and they are bringing back to use some excellent ideas, even though the conditions under which the railways operate are in most case quite different from those which exist in this country.

We gain not a little, also, from railway representatives from abroad who come to this country to study our practices, and who frequently make suggestions which are helpful to us, whether they can be directly applied, or whether because of stimulating interest and thinking which may result in improvements. By and large, this interchange of visitation is very much worth while and doubtless can be conducted on an even larger scale with profit.

To-day's Program

THE Mechanical Division will assemble in the meeting room at the right of the stage in the main Exhibit Hall of the Auditorium at 9:30 a.m., daylight saving time, and is scheduled to adjourn at 12:30 p.m. The program follows:

Address: A. G. Pack, Chief Inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission.

Discussion of Reports on:
- Design of Shops and Engine Terminals
- Joint Committee on Utilization of Locomotives and Conservation of Fuel.

Election of Officers and Members of General Committee.

Adjournment.

Registration Figures

The total registration at four o'clock yesterday, Tuesday afternoon, is shown in the following table, together with similar data for the past four conventions. All records for the attendance of railroad men of all classes have been broken.

	1922	1924	1926	1928	1930
Mechanical, Division V	999	1207	1410	1525	1574
Purchases and Stores, Division VI	376	427	480	493	538
Motor Transport, Division VIII				56	71
Railroad guests				688	819
Railroad ladies	1008	1178	1191	1316	1165
Supply men	2290	2666	3122	2644	2531
Supply ladies	573	675	725	751	598
Special guests	907	1066	875	38	167
Complimentary				239	*
	6153	7219	7803	7750	7463

*Complimentary registrations this year are included in railroad guests.

In the registration figures which were published in the *Daily* of June 24, the print shop mixed up the figures somewhat. The number of supply ladies registered at four o'clock Monday afternoon in 1928 was 731 instead of 32 and in 1930, 588 instead of 164. The other data, however, and the figures for the total registration were correct as printed.

An Expression of Confidence

REPRESENTATIVES at Atlantic City of both the railway and railway supply interests have a warm place in their hearts for Secretary of Commerce Robert P. Lamont, since in a way he is one of us. The Executive Committee of the Railway Supply Manufacturers' Association at a meeting yesterday, enthusiastically adopted the following resolution, which was forwarded to Secretary Lamont by wire.

"WHEREAS, the Mechanical, the Purchases and Stores, and the Motor Transport Divisions of the American Railway Association, and the Association of Railway Electrical Engineers are just completing most successful joint conventions at Atlantic City in connection with the great exhibit of the Railway Supply Manufacturers' Association in the new Municipal Auditorium, and

"WHEREAS, the attendance of railroad officers and members has surpassed all previous records, and

"WHEREAS, Chairman McManamy of the Inter-

state Commerce Commission and President Aishton of the American Railway Association, in attendance at the meetings have expressed appreciation for the spirit of the meetings and the practical value of the exhibits,

"THEREFORE, notwithstanding the present conditions in the railway field, we are enthusiastic of the future. Our association extends cordial and best wishes to yourself and through you to President Hoover, and begs to assure you of our wholehearted support in the interest of a more prosperous industrial and business condition."

Closing of Exhibits

It is anticipated that the Mechanical Division will adjourn between 12:00 and 12:30 this noon. The exhibits of the R. S. M. A. will remain open for inspection about a half hour after the adjournment of the Mechanical Division.

W. C. Motter Dead

W. C. MOTTER, representative of the Barco Manufacturing Company and the Bettendorf Company at St. Paul, Minn., died Sunday morning. Mr. Motter was a Princeton graduate who brought exceptional ability, as well as a likeable personality, to the railway engineering sales field. Formerly a regular attendant at conventions of the Mechanical Division, he was prevented from being present this year by the lingering illness which caused his death. The funeral services were held at St. Paul Monday.

The Arch-Bar Truck Elimination Problem

DURING the past year the Arbitration Committee endeavored to ascertain the status of the arch-bar truck situation by determining, as of January 1, 1930, the number of freight cars which carry cast-steel truck side frames, the number equipped with arch-bar trucks, and the number equipped with arch-bar trucks which were programmed by the railroads for elimination. The number of railroads answering the Arbitration Committee's circular was 146, reporting 2,130,000 odd cars. Out of that number, 973,400, or practically 45 per cent, were equipped with arch-bar trucks and 646,000 were programmed for change, leaving 327,000, or 15 per cent of the cars which have not been programmed for conversion by the owners.

The private car owners replying to the circular numbered 106, reporting a total of 198,700 cars. Of these, 97,000, or 48.8 per cent, were equipped with arch-bar trucks; 36,000 were programmed for change, leaving 61,000, or approximately 33 per cent not equipped with cast-steel frames or scheduled for change. The total of both items—railroad and privately owned cars—leaves approximately 16⅔ per cent not equipped or programmed for conversion.

Conventionalities

John H. Allen, president of the Everlasting Valve Company, Jersey City, N. J., celebrated his seventy-third birthday last Sunday by playing golf with two other gentlemen who were seventy-three years young.

According to Vice-Chairman Tate at the Enrollment Booth, J. J. Maginn, superintendent motive power of the Nickel Plate, was the first railroad man to pass into the exhibition hall on Tuesday morning. He appeared a few minutes before eight o'clock.

G. M. Bellanca, head of the Bellanca Aircraft Corporation, and Henry Huss yesterday flew to Atlantic City to visit the convention as guests of Frank J. Baumis. A luncheon party given in their honor, included Mr. and Mrs. Lemp, Mr. and Mrs. A. R. Ayers, Frank J. Baumis, Miss Johnson, R. A. Dean and Samuel O. Dunn.

A. H. Fetters, general mechanical engineer, Union Pacific System, has long been an aviation enthusiast and about eight years ago designed and flew his own aeroplane. He now admits a slight change in his affections, but it is one which involves no loss of enthusiasm for the air. He has taken up gliding, which he says is a sport worthy of the name.

George H. Houston has become president of the Baldwin Locomotive Works since the conventions were last held in Atlantic City, and is therefore attending the conventions and surveying the exhibit at Atlantic City in that capacity for the first time. It is seldom that a man has entered the railway equipment and supply manufacturing industry through a position of such great importance, but within a short time Mr. Houston has made for himself a place as one of the leaders of the industry.

Many of the old friends of James T. St. Clair, formerly engineer of car construction, Atchison, Topeka & Santa Fe, who has been an active participant in previous conventions, will learn with deep regret that Mrs. St. Clair died on Monday night at Halifax, Nova Scotia. Mrs. St. Clair, who was known to many as a visitor at the conventions, was a sister of A. R. Wilson of the Hutchins Car Roofing Company.

Edmond H. Walker of the Bradford Corporation, and a past president of the Railway Supply Manufacturers' Association, did yeoman's work in behalf of Ambassador Morrow in the recent New Jersey Senatorial campaign. Ed started a scheme in Essex county which was exceedingly productive in reaching a large number of voters who are not ordinarily interested in the primary campaign. Nobody, of course, can tell how much effect it had on the results, but something surely happened in Essex county, with a landslide that surpassed the imagination of even the strongest and most optimistic Morrow supporters.

H. H. Timken, of the Timken Roller Bearing Company, and his son, H. H. Jr., are spending a few days at the convention. Mr. Timken is enthusiastic over the results that are being obtained from the locomotive equipped

with Timken bearings, but insists that this application is not much of a feat, since roller bearings have had to stand up under far more severe service in different varieties of industrial applications. He feels strongly, also, that just as it has been necessary to speed things up in industrial processes, so it will become increasingly necessary to speed up all forms of transportation, and that in order to do this railroad officers must be prepared to make radical changes in their designs and practices.

F. E. Dodson, chairman of the Enrollment Committee, was presented with a complete set of matched Zutchart-Nicholls golf clubs and a dozen U. S. Royal golf balls Tuesday noon by the members of his committee. In presenting the clubs Harry Burrhus, the vice-chairman, spoke of the patience and untiring fidelity "Doddy" has put into his work and voiced the sentiments of the entire committee when he said that it had been a pleasure to work under his direction. Mr. Dodson was completely surprised with the gift and thanked the committee for its thoughtfulness and consistent help throughout the conventions. "Now that I have such a good set of clubs", he said, "I shall have to improve my game to make it worthy of the clubs."

Registration, American Railway Association

Division V—Mechanical

Abbot, R. Boone, A. G. S., Reading
Alexander, Nath, For. Elec., Reading
Armstrong, L. M., For Eng., P. R. R.
Ayers, A. R., Genl. Mgr., Nickel Plate, Marlborough
Ballda, F. E., M. S., New Haven, Ambassador
Barr, P. W., Insp., Penna.
Bauer, C. V., Draft., N. Y. C.
Beck, L. A., Asst. to Pres., N. S.
Benson, M. R., M. M., M. C., Princess
Blair, C. P., Draft., N. & W., Ritz-Carlton
Bohnstengel, Walter, Asst. Eng. Tests., A. T. & S. F., Colonial
Bonhoff, E. L., Gen. For., Penna. R. R.
Bordwell, H. J., G. M., E. R. R., Shelburne
Bunston, B. T., C. C. to M. M., Penna.
Butt, F. W., Asst. Eng., N. Y. C., Runnymede
Carmody, J. A., Supt. Elec. Eng., N. Y. C., Arlington
Chase, E. P., Asst. Engr., P. R. R.
Clark, Jos. F., Asst. Treas., W. & D. B. S. L.
Clements, M. W., V. P., Penna.
Colcord, W. J., A. R. F. E., Penna.
Conrad, R. J., Asst. For., Penna., Fredonia
Cook, Bernard, G. F., N. & W., Ritz-Carlton
Corcen, A. H., Designer, N. Y. C.
Crawford, J. E., Genl. Mgr., N. & W., Ritz
Cromwell, E. G., Spl. Insptr., B. & O.
Crooks, W. B., Trav. Insptr., Southern
Currie, H. A., E. E., N. Y. C., Runnymede
Day, J. C., Genl. For., P. R. R.
Decker, H. C., Draft., P. R. R., Chalfonte
Deeter, D. H., M. M., Reading
Dice, Agnew, T. Jr., Supt., Reading
Doarnberger, J .A., Mstr. Blr. M., N. & W., Ritz
Driscoll, J. P., M. M., Erie, Rio Grande
Dunn, A. C., R. F. E., Penna.
Ewing, C. H., V. Pres., Reading, Shelburne
Fackier, E. M., A. G. C. I., Reading
Falck, F. M., Gen. Mgr., Reading, Shelburne
Fell, J. J., V. P. Comp., Penna. R. R.
Fildes, F. K., Asst. Eng., P. R. R., Ambassador
Geddes, D. Y., Supt., Penna., Chalfonte
Goodman, S. V., Asst. Eng., Penna.
Gorman, T. F., Shop Supt., Erie
Hamilton Taber, E. of M. P., P. R. R., Chalfonte
Hankins, F. W., Ch. M. P., Penna.
Hatch, V. F., G. F., P. R. R., Stanley
Hauser, Percy, For., P., Chalfonte
Hewitt, H. B., Supt., Phila. Rapid Transit
Hofmmann, K. E., Asst. Eng. Tests, Penna., Princess
Johnson, E. L., A. E. of T., N. Y. C., Haddon Hall
Jung, A. A., For., L. I.
Jung, Theodore, For., L. I.
Kane, J. P., Supt. Forge Shop, B. & O., Chalfonte
Kaucher, R. N., Ch. Draft., Reading
Keller, S. S., Insptr., B. & O., Merchant
Kelly, Wm. M., Genl. For., P. R. R.
Kent, T. J., A. F. C. I., Penna.
Kleinschmidt, A. J., Engr., Penna.
Koch, Geo. B., G. F., P. R. R., Chalfonte
Koch, Philip, F. E. H., Reading
Lehmer, M. E., E. H. F., Penna., Fredonia
Lyons, W., Erec. For., N. Y. C. & St. L., Shelburne
Maginn, J. J., Supt. of M. P., Nickel Plate, Marlborough
Martin, A. W., Supt. Shops, Big Four, Colton Manor
Martin, C. W., H. L. Supvr., B. & O., Madison
Martin, Jacob, G. F., Big Four, Colton Manor
McCarthy, F. F., Spec. Asst. Supt. M. P., N. Y. C., Ambassador
McGill, A. M., Asst. S. M. P., L. V., Princess
Michael, J. B., Mech. Inspr., S., Princess
Morrow, S. A., Eng. House For., L. V., Stanley
Moses, H.K., M. M., B. & O. C. T., Colton Manor
Oler, B. F., Asst. Engr., Penn.
Pei, C. P., Fuel Supvr., N. P., Ambassador
Phelps, B. P., Engr. of Shops, A. T. & S. F. E. Shelburne
Porter, W. B., P. R. R., Penn Atlantic
Prendergast, John L., Gen. For., L. V., Stanley
Printz, S. E., Eng. Tests, R. V., Chalfonte
Rochester, R. K., Genl. Mgr., Penna.
Rose, James A., M. P. I., Reading, Colton Manor
Shank, Edward L., Asst. For., Reading
Shape, W. W., R. F. E., P. R. R.
Slaughter, Evans S. S., V. P. & G. M., Wildwood & Del. Ry.
Small, J. W., Ch. M. O., C. & O., Ritz
Smith, H. E., Engr. of Mtl., N. Y. C., Holmhurst
Stedman, W. M., Ch. Chemist, B. & O., Haddon Hall
Stevens, Geo. F., Asst. Eng., Boston & Maine
Stohlman, Geo. C., Secy. to Pres., M. P., Marlborough
Stubbs, Charles, R. H. F., Erie
Sudbonough, C. B., Asst. V. P., Traf., Penna.
Sultzker, Jos., A. G. M., Barber Asphalt., Brighton
Sutherby, A., M. M., Erie, Traymore
Tate, J. H., Trn. Contr. I., R. F. & P. R. R., Princess
Teufel, W. O., A. M. M., Penna.
West, H. R., C. C. to A. to P., N. S.,
Wetzel, N. F., Plant Engr., Big Four, Colton Manor
Wills, Everett, D. R. F., P., Morton
Wills, G. F., Insptr., B. & O., Dennis
Winship, L. C., Elec. Eng., B. & M.
Woodward, Geo. D., G. F. E. D., Penna. R. R.
Wyrough, H. M., Asst. M. M., P. R. R.
Yates, Harvey Q., For., P. R. R.
Yohn, A. E., G. M., H. & B. T., Cheltenhem Revere
Young, J. B., E. of T., Reading, Haddon Hall

Division VI—Purchases and Stores

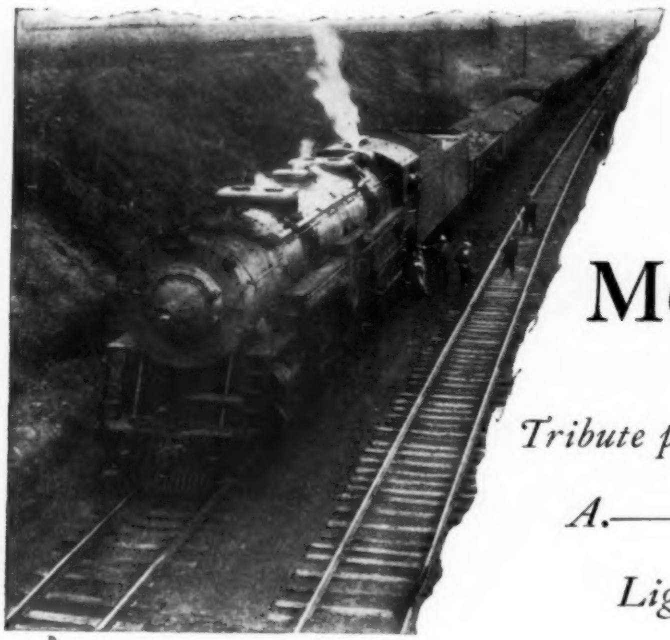
Fluth, G. E., Dist. S. K., Missouri Pacific Lines, Strand
Dozier, S. H., A. P. A., N. S.,
Laird, H. D., Matl. Supr., C. R. R.
Lingenbrink, Hermann, Tracer, B. M.

Motor Transport

Field. W. C., Supvr. Str. Dept., W. J. & S. S.

Special Guests

Austin, William Off. Engr., Reading
Baughman, C. L., A. P. T. M., P. R. R.
Beamon, Geo. W., Chemist, M. P.,, Haddon Hall
Benney, J. W., For., P.
Bockie, John, Wreck Master, Reading
Boggs, R. W., El. Insp., Reading
Corfield, Wm. D., Genl. Frt. Agt., Reading, Ambassador
Detwiler, Harvey L., Insptr., I. C. C., Commercial
Fitzgerald, D. W., For., Penna.
Force, C. E., E. H. F., D. L. & W., Jefferson
Franciscus, David L., Smoke Insptr., Reading
Gattis, C. H., A. G. P. A., S. F. E. L., Traymore
Girard, X. G., Engr.
Glass, Robt., E., C. B., Penna.
Gousman, A. R., C. S., Penna.
Henderson, J. F., Mach., Penna.
Herring, W. W., C. C. to Asst. to Pres., Southern, Kentucky
Hildebrand, F. A., For., Penna,
James, F. M., Clerk, P. R. R.
Lagen, V. A., Frt. Repr., P. R. R.
Laning, Henry L., Val. Engr., Reading
Lindaman, H. W., D. W. C., P. R. R.
Lingenfelter, A. B., Inst., Penna.
Main, G. A., Sec. to G. M., N. & W., Ritz
McDowell, W. Hunter, Cost Eng., Reading Co.
McGowan, J. P., G. B. F., B. & O., Kentucky
Mefford, W. F., F., S., Elberon
Menholtz, E. C., Chem., M. P., Haddon Hall
Mettinger, E. E., Clerk, Penna.
Novy, Gunther, Spec. Asst., D. & H., K. of C.
Oehlert, H., Clerk, Penna.
Ribblet, C. J., A. T. M., Penna.
Rose, C. H., Insptr., P. R. R.
Rosenberg, Carl R., Draft., B. & L. E., Haddon Hall
Sample, W. A., Loco. Supvr., V. & O.
Sanderson, H. M., C. C. to Pres., C. R. R. of N. J.
Sasser, Phillip, Marlborough
Scheifele, John, R. F. E., Reading, Ariel
Tangye, W. A., A. E. H. F., B. & O.
Tayor, Robert, B. & O., Runnymede
Telford, Alexander, Asst. Gen. P. A., S.
Tolson, R. R., Mgr., W. Term., Morton
Ulrich, Paul M., Machinist, Penna.
Varner, Lawrence L., Clerk, Penna.
Vasev, M., Mining Eng., Russian Eng. Comm., Chelsea
Wagner, Geo. W. Jr., A. B. I., Atlantic City Railroad
Waite, Norman E., Ins., Reading
Waite, Norman E., Ins., Penna.
Walters, W. H., Asst. Eng., Penna., Penn Alto
Warren, R. B., Engr., B. & O., Errickson
Warrington, J. Burwell, A. T. M., Reading
Yaskowitz, Victor R., Drafts., N. Y. C.
Yingling, D. W., Machinist, P. R. R.
Zimkowski, Francis, Son of Supt. E., N. Y. N. H. & H., New Richmond



Vauclain Speaks at Fifth Session of Mechanical Division

Tribute paid to the accomplishments of the A. R. A.——Reports on Locomotive Design, Car Lighting and Electric Rolling Stock

CHAIRMAN SMART called the fifth session of the Mechanical Division to order at 9:30 a. m., Tuesday. Introducing Samuel M. Vauclain, chairman of the board, Baldwin Locomotive Works, as the speaker of the morning, Mr. Smart referred to him as the "Daddy of the locomotive builders." Mr. Vauclain in his introductory remarks said that this paper was of an historical nature. Some years ago he was invited to deliver an address before the Pennsylvania Society at Washington, D. C. He had been requested to speak on transportation, but in looking over the audience he came to the conclusion that they probably knew less about the state of Pennsylvania than they did about transportation. So he spoke to them about their own state and found that there were not more than a half dozen people in the audience but what were surprised to find out what a glorious state they represented. "This morning," Mr. Vauclain said, "I want to try to bring before the members of this association some realization of the glorious association to which they now belong, a time-honored institution, an institution that has greater value to the railways of the entire world than any other thing that has happened since its inception."

Mr. Vaucain's address was followed by the committee reports on Locomotive and Car Lighting, Locomotive Design and Construction, and Electric Rolling Stock.

The moving pictures of the Siskiyou power brake road tests were shown again in addition to animated technical drawings, showing the generation and use of steam in a steam locomotive, which were shown through the courtesy of the Atchison, Topeka & Santa Fe.

Address by Samuel M. Vauclain

Pioneer locomotive builder rehearses the high points of steam locomotive development and the A. R. A. Mechanical Division

S. M. Vauclain

The American Railway Master Mechanics' Association, from which our present organization sprung, was organized at a meeting in Cleveland, Ohio, on September 30 and October 1, 1868. Its constitution and by-laws were adopted. The preamble to the constitution read as follows: "We, the undersigned railway master mechanics, believe that the interests of the companies by whom we are employed may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business. To this end we do establish the following constitution."

The list of members was very short, composed of the leading superintendents of motive power of that day, among them many of my personal friends to whom I looked up with the utmost respect, such as Isaac Drippes, of the Fort Wayne and Chicago; J. A. Johann, late of the Pacific of Missouri; J. B. Kersey, of the Lehigh Valley; D. O. Shaver, of the Pittsburgh shops of the Pennsylvania; Reuben Wells, of the Jeffersonville, Madison & Indianapolis. These gentlemen, with their friends, had the courage to form this association for the same reason that Benjamin Franklin established the American Philosophical Society, for the promotion of useful knowledge, and more especially knowledge in connection with railway affairs. The initiation fee was one dollar, and "all persons having charge of mechanical departments of railways, known as superintendents of motive power and machinery, general master mechanics, or master mechanics, also any persons acting subordinate to the above named, whether known as master mechanics or general foreman whose names

shall be presented by their superior officers for membership, also any person who may have been at any time master mechanic of a railway, but who may not for the time being hold such position, and is not engaged in other business," were eligible to membership. The names of the latter applicants, however, had to be presented by their superior officers. Any person who had previously been a master mechanic, not engaged in any other business, likewise was eligible.

Standardization of Rolling Stock Considered

It was about this time that the railways of the country were considering the standardization of rolling stock. The Civil War had been brought to a close, leaving the railroads in a rather impoverished state so far as equipment was concerned. My early career was with the Pennsylvania and from a small boy became very familiar with the various types of locomotives in service on that road. And, believe me, it was difficult to find any two that were quite alike. In the late sixties it seemed to be a necessity to modify or rebuild every locomotive put through the shops for general repairs. It was during this stage of railroading that John P. Laird, then in charge of motive power and machinery, introduced many features of locomotive design that are still being used in American railway practice, although the growth of the locomotive from that day to this has naturally caused these features to be re-designed and strengthened to take care of the excessive strain added from time to time. It was no uncommon thing to see a Baldwin eight-wheel connected freight locomotive with a flexible beam truck changed to a six-wheel connected locomotive by substituting a pair of truck wheels for the front driving wheels of the flexible truck.

Cylinders of unusual diameter for that day were employed by him, usually about 21 in. in diameter. Large driving wheels, such as had never been used before on that line, were experimented with. It was probably due to this malformation of locomotives that caused the Pennsylvania to undertake the standardization of its power. Under J. B. Collin, who became mechanical engineer of this line, several types best suited to the general service of the road were produced. For ordinary passenger service locomotives with cylinders 17 in. by 24 in. and driving wheels 62 in. in diameter, and which proved to be successful, were used and served the purpose of the railroad for many years. The exhibition locomotive of the Pennsylvania at the Centennial Exposition in Philadelphia in 1876 was one of this type and, if my memory serves me correctly, was given the number 44.

Heavy freight locomotives for operating the mountain grades had cylinders 18 in. by 22. in., and three pairs of driving wheels, 50 in. in diameter, with a four-wheeled leading truck. The fireboxes, if I remember correctly, were 33 in. wide and 78 in. long. For high speed freight service on the lower grade divisions a similar engine with cylinders 18 in. by 22 in., but having driving wheels 6 in. larger, or 56 in. in diameter, and 6-in. shorter fireboxes, were deemed sufficient. These two types of freight locomotives were modeled after the 29½ D type freight locomotives built for the Pennsylvania by the Baldwin Locomotive Works, scores of which were then in operation on the line.

68-In. Driving Wheels for Passenger Power

The next modification of the passenger engine that was introduced had 68-in. driving wheels for high-speed service, but this type was not persisted in, due to bending of the axles. Passenger engines of the same type but with the fireboxes suitable for burning anthracite coal, were constructed. The crowning event, however, was the building of the Class I freight locomotives of peculiar design. Everything was done in the way of reducing weight in order that the axle load on the rail should not exceed the limit of 18,000 lb. Hundreds of this type of locomotive were built, and the completion of one order at the plant of the Baldwin Locomotive Works in 1882 was responsible for my advent in eastern territory and later connection with the works.

Standardization of parts and a reduction of the number of types which followed the organization of the American Railway Master Mechanics' Association were beneficial to the different railways of the country. It must be remembered that at that period there were many more railroads separately operated than we have in the country today, and that every master mechanic, and sometimes those in higher authority, had ideas of their own for the improvement of the locomotive. In my judgment the present status of the American locomotive is due largely to the general report on the part of everyone connected with the mechanical department of a railroad applying themselves to the further improvement of these machines of power. It was soon found that this gathering together once a year to express views also necessitated a getting together between meetings, not only in consultation, but in the conducting of examinations into the value or virtues of various devices. It resulted in the establishing of committees whose duty it was to report to the meetings.

Some Early Problems Still Unsolved

It is interesting to note some of the subjects recommended for discussion, each of which was felt to be highly important and extremely pertinent to the needs of the railway motive power employed. "Are steel plates preferable to iron in the construction of locomotive boilers?"; another, "What should be the thickness of steel or iron plates when used in the construction of the outside shell of a 48-in. boiler?" The third, I believe, has been under discussion ever since and has not yet been satisfactorily decided; namely, "What water space is deemed best around the sides and ends of the furnace, both for wood and coal-burning engines?" The question of the durability of steel for furnaces and flue sheets as compared to that of copper or best iron; another much-discussed question of the day, as to "what size flues and what length will give the best results in wood and coal-burning engines?" They further discussed the wear and tear of steel tires, the prevention of incrustation of boilers, as to what type of safety valves would be best and safest to use. The eleventh question was one that promised to upset all previous advantages gained by engineers from experience on their respective iron steeds whether the adoption of a "lock-up" valve that could not be interfered with by the engineers would tend to prevent explosions which "are now so frequent." These were each very important at that day in the year 1868. They have probably all been nearly, or very nearly, solved in the 62 years of the life of this association.

The second annual meeting was held in Pittsburgh and an almost equal number as then enrolled were added on this occasion to the membership of the association. Such men as F. A. Brown, of the Delaware, Lackawanna & Western; J. M. Boone, familiarly known as Jim Boone, of the Pittsburgh, Fort Wayne & Chicago; H. D. Garrett, of the Pennsylvania; J. H. Setchel, of the L. M. C. & X., and in after years with the Pittsburgh Locomotive Works. The proceedings of these conventions are not only interesting, but were of considerable value to railroad officers

from presidents down, and also to the builders of locomotives who construct the motive power for the railroads —"At a price!"

Locomotive builders, of course, were constantly in competition with each other as to the power of their engines and as to excellence generally in their performance. So long as the use of light rails and mud ballast on many roads was rather general, the size of locomotives for many years remained practically the same; the permissible load on the rail per axle determining in most cases the size or type to be built. It was thus we jogged along until the panic of 1873 had about closed. The railway riots of 1877 brought about a resumption in business in the country, and a desire was then manifest on the part of everybody to give labor more hours of employment at better pay.

Introduction of Steel Rails Increased Permissible Wheel Load

At that time steel rails of larger section were being rapidly introduced, and the iron rail was almost entirely abandoned. Stone ballast and steel bridges were taking the place of the earlier types in use when traffic requirements were of a different character. Iron boiler plate was also being discarded and steel substituted. The carrying capacity of freight cars was increased. The abandonment of the four-wheeled coal cars had begun. Speed and power, and more economical coal consumption, here as well as abroad, were receiving close consideration and gave rise to the idea of applying compound cylinders to locomotives in place of the single expansion type then generally in use.

Naturally, the locomotive builders became interested in this substitution, and a distinct type was produced. Many, however, were modifications of the two-cylinder type at that time in use abroad, whereas, the Baldwin Locomotive Works brought out an original design of four-cylinder compound in which the high and low pressure cylinders were superimposed, and operated by one piston valve. The crosshead common to the two-cylinder type was used with one main rod coupled to the crank pin. Naturally, an innovation of this kind attracted widespread attention in motive power circles, here and abroad. The concensus at that time, I believe, was that the device was merely an experiment and would not come into general use. A committee on compound locomotives was appointed and made its first report at the convention held at Old Point Comfort in the year 1890, but so few locomotives had been built during that year in the railway shops and by the builders that sufficient experience had not been had with them to sustain much discussion regarding their merits or otherwise.

In the following year, however, the discussion on compound locomotives was animated. The convention had as its president, John MacKenzie. Those of you here present who were members then may remember him, and will recall his positive character. Dear old Mac, how he used to chop things off when he thought that enough had been said on any subject. The convention in those days were very orderly. George Royal always opened up the meetings with a prayer. I must confess that most of us failed to remember what he had said when discussions grew warm, and at a time when our minds individually were practically unchangeable. John Hickey and William G. Arstang were in line for the presidency; Stewart was treasurer; not that persistent little Scotchman, Angus Sinclair, whom you either remember or must have heard of,—these made a combination of officers of the association hard to beat. We had on the floor such leaders in discussion as Barnett, Barr, Casanave, Forney, Gibbs, Johann, Lauder, Lewis, Meehan, Setchell and Wells. And it must be kept in mind that each of them was deeply concerned with the affairs transpiring and attended every meeting, never missing a minute. They were interested not only in the association itself, but as to the action that might be taken and what would necessarily be passed on to those who in the future would have to "carry on". The motive power men all over the world were invariably desirious of receiving the proceedings of those conventions, so that they might understand more fully the progress being made in locomotive design and operation in this country.

These early meetings took place forty years ago. Many of the discussions then indulged in would today appear somewhat ludicrous to those not actively engaged in the construction and maintenance of motive power in those days.

Early Misconceptions About the Steam Indicator

For instance, M. N. Forney, who handed down to us one of the most valuable publications, Forney's Catechysm of the Locomotive, during one discussion as to the advisability of railroads establishing chemical and physical laboratories, discovered that many of the members considered them a useless expense, and that others strongly recommended their installation. Mr. Forney stated that he could not recall a single case of any person who had found out by a steam indicator anything that was worth knowing. This statement made the pot boil and the discussion proceeded fast and furiously. One member stated that he designed locomotives to draw cars and not to draw indicator diagrams—a very unwise expression even at that time.

It was then that the question of the use of steel axles came before the committee, their substitution for those made of iron, and today we wonder why iron axles were so tenaciously adhered to by many of the most prominent railroads of this country, which today would not dream of using anything but steel axles of the best quality procurable. I remember the difficulty I experienced in getting steel axles of a grade that in my judgment would prevent breakage. As everyone had been accustomed to the use of iron, the desire was to use a low grade of steel with carbon probably ranging from .15 to .25. In order to secure axles of .40 carbon steel, I was compelled to purchase blooms from steel products and forge the axles ourselves. One of the most skeptical of axle manufacturers said he would be glad to test one of these axles for me, so that I might see how inferior it would be to those he was making. The result of the test, however, changed his mind, and no more low carbon steel axles were thereafter manufactured by him.

The discussion on the practicability of chemical and physical laboratories was ultimately most decisive as to the advisability of having them. It was still young when the Pennsylvania had a well organized laboratory system, chemical and physical. My personal knowledge of metals, gained during the creation of these laboratories, was of great value to me in after years as a manufacturer. I remember well when John Cloud, a young graduate, came to Altoona to take charge of the physical laboratory, and such testing as the Pennsylvania had to do. The reason I am able to remember this so distinctly is that I was the exclusive motive power of the test department. We had an old Fairbanks beam testing machine operated by a hand wheel and screw, and each time it was necessary to pull any specimens I was delegated from the work shop to pull the wheel around, thus sup-

plying strain to the specimen, the entire performance being supervised by Mr. Cloud. He is still very much alive, and is in London as the representative of the Westinghouse Air Brake Company. In consultation with Dr. Dudley, of the chemical department of the testing laboratories, he told me I was quite right in the use of .40 carbon steel, as he was even then preparing specifications for the use of .50 carbon steel for axles and crank pins. The specifications for all materials thereafter to be used on railroads were discussed at great length. And even now the tendency is to fully consider them.

The past forty years, in my judgment as a locomotive builder, have brought about the greatest advances in locomotive construction in the United States that the world has yet seen. In no country are such powerful engines used, in either passenger or freight service. The tractive force of locomotives has increased enormously, in some cases being as high as 160,000 lb. in one unit, and under the guidance of one engineer. Locomotives having two cylinders, three cylinders and four cylinders, and a few even of six cylinders, have been built in an endeavor to reach the maximum permissible for the conditions under which they must be operated. The use of compounding has given way to the use of the superheater and higher boiler pressures. Compounding itself brought about the increase of boiler pressure from 120 lb. in the old days to 200 lb. or more at this state of motive-power development. The most economical boiler pressure, to be used, frequently was a matter for discussion before this association.

Many Economy and Capacity Increasing Devices Developed

I remember how many, many hours were devoted to the question of brick arches and their advisability and the apparent loss or economy perhaps in their use. This matter, however, was definitely solved by the American Arch Company, and at present very few engines are constructed without brick arches. A new substitute for the arch pipe supporting the brick arch has appeared in the form of a syphon, thousands of which are now in use in this and other countries. Perfection cannot be had with any device unless it is used sufficiently long that any weakness can be detected and corrected.

The feedwater heater, which was attempted many years ago, has been brought to such perfection that locomotives of high power are incomplete without one of the several feedwater heating devices that have been placed on the market.

The old pinch bar that we had used in our more youthful days to start in motion the wheels of heavily loaded cars has now had substituted for it in locomotive practice the "booster." The perfection to which this device has been brought is due to the skill and determination of its engineers and promoters and the opportunities that have been given them by railroads brave enough to use it in its early days so that the manufacturer could find out and correct any weakness in its construction.

From the trailing truck of a locomotive the booster has been transferred to the trucks of the locomotive tender, thus materially increasing the starting power or emergency tractive power of many of our largest locomotives. And as the engines have not only increased in size, in the permissible load at the rail, in the limit of width permissible on the various lines, its length has been greatly augmented in its development, which also holds good for the tender which is attached thereto.

From the ordinary locomotive tender of 2,000 gal. capacity of 40 years ago, modern locomotives now have tenders with a capacity ranging from 18,000 to 22,000 gal. of water, and from 20 to 30 tons of coal. Monstrous trucks are necessary to carry these tenders of such vast weight. Railroads have been compelled to renew their turntables with others of sufficient length to turn these engines, and enginehouses or engine shops have had bay windows added in order that the locomotives could get completely under cover when necessary to make repairs.

Another great advance is that made in the method of lubrication of both cars and locomotives. At this time the substitution of roller bearings is being inaugurated and I believe in the very near future, notwithstanding their great expense, grease boxes will be done away with on all railroad equipment. The development of lubrication made possible the continuous operation of locomotives, so that many now make as much as 800 to 1,000 miles without being disconnected from the train. The method has attracted much attention in other countries. The Baldwin Locomotive Works built for the South African State Railways the largest narrow gage locomotives ever used by the road, equipped with a lubrication system that enabled the engines to operate in fast passenger service 1,000 miles without disconnecting them from the train.

Solid Rods and Pennsylvania Type Crosshead Effect Improvement

The abandonment of all straps, keys, etc., from connecting rods has been a development that made rapid progress in the last decade, and the modern locomotive is equipped entirely with solid end rods.

One of the greatest improvements has been the type of guide and crosshead now standard on the engines of the Pennsylvania. Engines built for the Baltimore & Ohio and equipped with these guides and crossheads have operated as high as 180,000 miles without having had any work of any kind done to the appliances. In my judgment this type should come into very general use, as it can be applied to any locomotive and would add little, if anything, to the cost of the engines, and in all instances would cheapen their upkeep. A reduction of reciprocating parts would follow and there will be no lining up of guides nor replacement of crosshead gibs owing to excessive wear.

The problem of getting sufficient coal into the firebox of a large locomotive had to be solved. The human endurance limited the effectiveness of the larger engines. A little fellow by the name of Street solved the problem temporarily, and our success with the automatic stoker, as now applied, is due to his early effort, as all other methods were most discouraging at the time. Today no consideration at all is given the possibility of being able to fire successfully the huge monsters we are building. The designs are such that firebox length can be had to obtain proper grate area, and now 23 ft. in length of a firebox has been properly taken care of by the automatic stoker.

My remarks today, touching as they do the high spots only, would not be complete did I fail to refer to the probable continuance of the steam locomotive on our railways, as well as in other lines of industry where it seems now to be indispensable.

The Steam Locomotive a Promoter of Prosperity

We have been for more than 100 years developing this benefactor to mankind. Wherever it has gone it has promoted prosperity and carried civilization into lands at all corners of the earth.

In 1895 locomotive builders and electricians became

interested in the designing, development, introduction and consequently the construction of electric locomotives. I had the pleasure of being associated with George Westinghouse when we first joined forces, in that same year to develop electric locomotives for all classes of service. We are not ashamed of our accomplishments in the time that has elapsed. For industrial work this type has superseded all others. The steam dummy is a thing of the past. The electric industrial locomotives, however, are even now giving way to small types of locomotives either directly driven by gasoline or Diesel motors, or indirectly driven by gasoline or Diesel electric devices. The art is progressing rapidly. The perseverance of those engaged in the construction of these machines is highly commendable. The electric road locomotive for heavy railway traffic and high speed passenger service is now a proved success wherever there is sufficient traffic to warrant its introduction. In the very near future we shall have electric operation of railways along the Atlantic seaboard extending from Boston, Mass., to Washington, D. C. And as approximately 40 per cent of the population of the United States is east of the Allegheny mountains I can see no reason why such electric operation would not be more economical and satisfactory than when operated by steam motive power. There is an even greater desire for the elimination of smoke and dirt in our congested centers, especially here in the East, and regardless of the expense to which our railroads may be put, electrification must eventually be installed. And if these large centers through which the railroads pass must be electrified, there is no reason why electric locomotives should not be coupled up to all trains, operated continuously, and without change of engines at any point.

Diesel Power Promises Economies for Many Purposes

The development of the Diesel locomotive is having the attention of engineers and railway officials throughout the world, and it is progressing well. There is one great handicap to a more general introduction of this class of power, namely, the great expense involved. While all locomotive builders are vitally interested in the progress of this type of locomotive, some of our railroads are also indulging in the experience of developing these engines, which I am sure in the course of time will come into general use for many purposes.

But notwithstanding all these substitutions for the steam locomotive, it is my judgment that we are just beginning to realize what actually can be done with the steam engine in the way of continuous performance, economical performance, and reduction in maintenance that will continue it in service, so that it can be more ably discussed in the year 1980 than it will be at this convention in 1930. I have not lost interest in this greatest of all human devices, and will continue in future as in the past to be its advocate and builder.

Report of Committee on Locomotive and Car Lighting

New power requirements are creating a demand for special forms of power generators

W. E. Dunham
Chairman

The various phases of locomotive and car lighting which the committee has been studying during the past year are are: 1—Locomotive train lighting for suburban trains; 2—Locomotive train lighting for main-line trains; 3—Positive mechanical axle generator drive; 4—Revision of incandescent lamps schedule; 5—The adoption of a standard lock and key for generator lamp-regulator lockers; 6—Standardization of battery capacity rating; 7—Electric refrigeration as applied to passenger-train cars; 8—Rail motor-car lighting; 9—Locomotive cab lighting.

The lamp schedule is included in the report in tabular form and lists types of incandescent lamps used in locomotive, train, motor-coach and street-car railway lighting service. The committee recommends that it be adopted as recommended practice. The use of a standard lock and key for generator and regulator lockers is not looked upon favorably. A review of the practices of various railroads indicates that any general use of any one type of lock and key with the consequent scrapping of most of the lock and keys now in use is not justified. All other subjects studied by the committee are reported on as follows:

Locomotive Train Lighting for Suburban Trains

This is, in the main, the simplest form of head-end electric train lighting. When the problem is confined solely to the lighting of the cars, it is extremely simplified. At the present time there appear to be four systems in use, as classified by the distribution of the current supplied by the turbo-generating unit located on the locomotive. These are:

(1) A single unit supplying current for lights on the locomotive and lights on the cars.

(2) A single unit supplying current for lights on the locomotive and lights and batteries on the cars.

(3) A small unit supplying current for lights on the locomotive and a larger unit for supplying current for lights on the cars.

(4) A small unit supplying current for lights on the locomotive and a larger unit for supplying current for lights and batteries on the cars.

The difference between schemes (1) and (3) usually is due to a desire to use a 32-volt installation on the locomotive and a 64-volt installation on the train, the latter to reduce the illuminating variations due to line drop in voltage.

The difference between schemes (1) and (2) and between (3) and (4) is the addition in (2) and (4) of batteries on the cars to carry the lighting load when the locomotive is disconnected and to handle special features such as thermostatic control, etc.

Typical installations are in operation in the suburban territory around Chicago. Each group is being extended on the respective railroads as originally standardized as to generator size and light load per car, with the exception that with increased train lengths, larger units have been found necessary in cases where the cars are equipped with batteries. The original 7½ kw. units are being replaced by 12 kw. units. The 7½ kw. units are still being used in the second type of installation, even with the longer trains.

For suburban trains, branch line trains and even the average shorter main line trains, this scheme of lighting is extremely satisfactory. It has the favorable advantages of a low initial cost and low maintenance cost, as well as efficient illuminating results. As a means for improving the service on minor lines, this method of lighting passenger train cars is recommended to the members.

Locomotive Train Lighting for Main-Line Trains

The generally satisfactory lighting and service obtained in the various suburban and short-run train installations with locomotive head-end generators has naturally raised the question as to its use on main line trains of importance. Where the main line train operates as a unit from the initial to the destination terminal without cars being set out or cut in en route, the problem is as simple as with the suburban train. The maintaining of lights in the two sections of the train when separated at intermediate stations, or on the entire train when the locomotive is changed at an intermediate terminal, and the lighting of a car

while being set out and after being set out, all add complications to the main-line train problem. Batteries must be provided in some or all of the cars to meet these conditions of train separation, or else the passengers will be required to remain in the dark while the switching and terminal engine changing operations are being carried on after dark, unless some auxiliary lighting is provided. The fundamental data as to total generator capacity and battery requirements for each car in such an installation, as well as information as to battery action in such service, are not at this time available. Actual trials are necessary to develop these facts. Such a trial has been under way on the Chicago, Milwaukee, St. Paul & Pacific for some time. A train consisting of a combination mail and baggage car, a combination baggage and smoker, a standard coach, diner, four mid-train sleepers and one observation sleeper, and lighted by a 20 kw. turbo-generator located on the locomotive tender, has been operating with reasonable satisfaction for about a year. Each of the these cars, with the exception of the axle lighted diner, is lighted from the locomotive turbo-generator and each car, with the exception of the combination mail and baggage car and the coach, is equipped with a 300 amp. hr. battery.

This installation indicates the possibilities for this type of electric lighting on main line trains and should be carefully followed. The information obtained should show the limitations under the present state of the art.

Positive Mechanical Axle Generator Drive

With the increasing use of electrical current on our passenger train cars for lighting and other purposes than lighting, and the absolute necessity for a full supply of that current at all times, it is quite evident that, particularly in the northern sections of the country, an improvement over the belt drive as now used is necessary. Where snow and ice are present, belt slippage has become fatal to good and satisfactory generator performance. When snow and ice are not present, the average arrangements of belt drive are making first-class records as to efficiency and economical maintenance.

To meet this adverse weather condition, so-called direct mechanical drives of various arrangements are still being developed. Of the several designs, five are actually in service, about 130 installations being on record. All are giving encouraging service.

For the information of the members, the following description of six of the present more generally known positive drives are given:

The Bitterlick drive consists principally of a split worm gear attached to the car axle, meshing with a worm gear on a stub shaft direct connected by a universal joint to a hollow shaft which is also direct connected by a universal joint to the splined body hung generator armature shaft. The gear casing which also surrounds the axle is spring suspended from the car body and is provided with lateral rolling supports to adjust itself to truck angularity.

The Foote drive consists of an exposed split spur gear clamping the car axle. This engages a second spur gear of considerably wider face mounted on a shaft suspended from the truck frame by a pivoted support and arranged parallel to the car axle. Mounted on one end of this driven shaft and suitably housed is a bevel gear that meshes with a second bevel gear on the propeller shaft arranged lengthwise of the car. This propeller shaft is connected by a suitable flexible jointed shaft to the generator that is suspended from the car body.

Proper relative pitch diameters are obtained as between the split axle gear and the driven shaft gear by distance drums of proper diameters mounted on the axle and the driven shaft, and which maintain face contact.

The Pitt-Diehl drive consists of a large split spur gear mounted on a bushing, face keyed to the axle, the latter being turned to suit accurately and to A. R. A. dimensions. This gear engages a pinion mounted on a jack shaft arranged parallel to the axle. On one end of this jack shaft is a bevel gear which meshes with a second bevel gear mounted on a tail shaft and arranged perpendicular to the axle and parallel to the car. The drive shaft equipped with two universal joints connects this tail shaft to the generator shaft. The generator is hung to the body of the car. The entire gear assembly is housed. The housing rides at one end on the bearing surfaces provided on the large gear and at the other end is spring suspended from the truck.

The Pyle-National drive uses the usual split face belt pulley. Against the face of this pulley as the driving power, a continuous woven rubber faced belt is contacted, the belt running over a gear box pulley and an idler tension pulley. The gear box and the tension pulley are suspended from the truck frame. Through the self-contained gear box the power is transmitted to the generator by a flexibly connected drive shaft running parallel with the car. The generator in this installation is hung to the body of the car.

The Safety drive consists of a split sprocket secured to the car axle by tapered adjusting wedges. A Morse silent chain driven by this sprocket drives a sprocket mounted on a jack shaft, swing suspended from the truck frame and parallel with the car axle. Through a gear box and flexibly connected to same, the drive is delivered to the generator supported on the truck and with the armature shaft parallel to the car.

The Chain drive consists of a duplex bicycle type chain operating over a split duplex sprocket on the car axle and a solid duplex sprocket on the generator armature shaft. The generator is truck suspended and has the armature shaft parallel with the car axle.

As indicating the fundamentals desired in a direct mechanical drive, the suggestions made in the report of 1922 are included in this report.

The points that, in the judgment of the committee, should be avoided in designing a positive drive for axle generators are:

1. Construction which necessitates the use of a "special" axle.
2. Construction which in any way changes a "standard" axle.
3. Construction which necessitates the removal of the wheel from the axle in order that the equipment may be applied.
4. Construction which uses a helical spring in a plane other than that perpendicular to its axis.
5. Construction which, on account of wear, necessitates scrapping of material other than the material worn.
6. Construction which does not provide for maintaining pitch circles of bevel gears in contact.
7. Construction which does not readily permit the turning of wheels in center drive wheel lathes.
8. Construction which does not provide for the full movement of the axle in all planes.
9. Construction that does not provide efficient lubrication and protection to all working surfaces from dirt and grit.

The points that, in the judgment of the committee, should be provided in the design of a positive drive for axle generators are:

1. Connection to axle that can readily be removed.
2. Mounting of the axle generator on the truck or underframe of car in the simplest possible manner.
3. That the universal joints, if used, should have a free angular movement in any direction in excess of the angle between center lines of truck and car body as found on the curve of least radius over which the car is capable of moving in service condition.
4. That a safety device should preferably be provided which will operate to break the connection between the drive and generator in the event of the drive tending to become overloaded.
5. That the generators should be so mounted as to provide a maximum of accessibility.
6. That means should be provided by which the generator may be readily "motored."

These were and are offered as suggestions as to what would constitute the ideal positive drive and are not intended as definite and absolutely limiting recommended practices. It is recognized that the development of a practical, reliable and economical drive may necessitate a compromise with some of these recommendations.

Standardization of Battery Capacity Rating

In co-operation with the Train Lighting Committee of the Association of Railway Electrical Engineers and the Battery Manufacturers, a tentative specification covering the capacity rating of all car lighting batteries has been developed. During the coming year it is suggested that these ratings be used to the fullest extent to determine as to their ultimate desirability for adoption.

Capacity—The rated capacities of all car lighting batteries shall be based on the eight (8) hour discharge rate, which is one-eighth of the rated ampere hour value.

Values of not less than 85 per cent of the nominal rated capacity must be obtained after not more than three cycles of charge and discharge at normal rates and values of not less than 100 per cent of the nominal rated capacity must be obtained after not more than twenty-five cycles of charge and discharge at normal rates.

Test for capacity shall be made after giving the battery a freshening charge at the eight-hour discharge rate, until the voltage has remained constant for not less than two hours. The test shall include three consecutive cycles each consisting of a discharge at the eight-hour rate to a final voltage of 1.75 volts for the lead battery and 1.12 volts for the nickel-iron battery, followed by a charge at the eight-hour discharge rate for a period of two hours longer than the period of discharge.

The capacity of the battery shall be the number of ampere hours delivered on the third cycle; the initial cell temperature for this discharge to be not less than 75 deg. F. nor more than 85 deg. F. The interval between the beginning of the third discharge and the previous charge shall not be more than fifteen hours.

Voltage Limits—The terminal voltage of each individual cell at end of discharge shall not be less than 1.75 volts for lead cells and 1.12 volts for nickel-iron cells.

Temperature—The temperature of the electrolyte at beginning of capacity test shall be approximately 80 deg. F., but shall not be less than 75 deg. F., nor more than 85 deg. F.

During the test the temperature of the electrolyte shall not exceed 115 deg. F.

Appendix—When comparing specific gravity readings, allowance must be made for changes in temperature of the electrolyte. The following formula is presented for this correction:

Lead—For each 3 degrees F. rise above 80 deg. F. in temperature of the electrolyte, add one point in specific gravity to the actual hydrometer reading, and for each 3 deg. F. fall below 80 deg. F. in temperature of the electrolyte subtract one (1) point in specific gravity from the actual hydrometer reading.

Nickel-Iron—For each 1 deg. F. rise above 80 deg. F. in temperature of the electrolyte, add .00025 to the actual hydrometer reading; and for each 1 deg. F. fall in temperature of the electrolyte subtract .00025 from the actual hydrometer reading.

Specific Gravity—The specific gravity of the electrolyte in the case of Plant type batteries shall not exceed 1.225.

The specific gravity of the electrolyte in the case of Pasted type batteries shall not exceed 1.260.

The specific gravity of the electrolyte in the case of nickel-iron type batteries shall not exceed 1.225.

Plate—A plate shall be applied to each tray which shall contain the following information: Type of battery; Capacity; Specific gravity; Normal charging rate; Manufacturer; Owner's No.; Date new.

Electric Refrigeration

While electric refrigeration, particularly on diners and similar cars, is not a direct function of the lighting plants on these cars, the installations, as regards the power features, are so intimately connected with the lighting plants that any line of demarcation is impossible. When first considered, direct connections to the generator and battery lines were figured out. However, as increased refrigerating units were installed up to the extent of full refrigeration of the ice boxes, coolers, etc., it has been found necessary to install separate units to operate the refrigerating plant, duplicating the original generator and battery on the car and also increasing the size of both installations. These duplicate installations are suitably arranged for parallel connecting.

The necessity for the most efficient generator drive under all conditions of weather and car movement is particularly noticeable with the load demands of refrigerating machinery.

It is evident that the comparatively inexpensive electric current available for industrial and home use that has materially aided in extending mechanical refrigeration in those fields, is not available for passenger train car installations and that it is only where particular conditions seem to justify the initial and operating cost that electric refrigeration is being applied to such cars.

The following installations have already been made or are being considered at this time:

New Haven—Ten dining cars—100 per cent refrigeration, two 1½ hp. condensers, two 5 kw. generators, two 600 amp. hr. batteries. One business car— two ½ hp. condensers, two 4 kw. generators, two 600 amp.-hr. batteries.

Milwaukee—Ten dining cars—one ½ hp. condenser. One dining car—two ½ hp. condensers.

Great Northern—Three dining cars—three-hole ice cream coolers, one ⅓-hp. compressor, one 5-kw. generator, one 600 amp.-hr. battery. One business car, 100 per cent equipped, one ⅓-hp. compressor, Delco plant, one 600 amp.-hr. battery.

North Western—Four dining cars—ice cubes only, one ½-hp. condenser, one 4-kw. generator, one 600 amp.-hr. battery.

Gulf, Mobile & Southern—One business car—100 per cent equipped, one ½-hp. condenser.

One car each is under consideration by the Santa Fe, the Baltimore & Ohio, the New York Central and the Pere Marquette.

Air conditioning on passenger cars is receiving serious consideration by the Baltimore & Ohio and by the Santa Fe. Each road is arranging to install units on one car. To operate this equipment, the Baltimore & Ohio is installing a single direct drive 110-volt, 10-kw. axle generator. The Santa Fe installation is two 7½ kw. 32 volt generators.

Rail Motor Car Trailer Lighting

At the present time there is no uniformity in the system of rail motor car trailer lighting. However, there seems to be a tendency to the following plans:

(1) *One Trailer Car*—Extend the motor car lighting circuit to the trailer without installing a battery on the trailer.

(2) *More than One Trailer Car*—If these trailers are not provided with independent electric-lighting facilities, to install an independent lighting unit, gasoline driven, on the motor car and light the entire train. Storage batteries are used on the trailers as may be required by operating conditions.

Where the trailers are regularly assigned, these two systems are extremely practical. Where the trailers are not regularly assigned and/or are operated also in steam trains, the use of independent axle generator equipment is advisable.

Locomotive Cab Illumination

An interesting development of a centralized gauge lamp installation for locomotive cabs which bids fair to reduce to a minimum the amount of wiring and lighting fixtures in the cab, consists of a tapered shaped housing located under the roof of the cab and through the back board. A single high watt capacity lamp is located in this housing. The front face of the housing consists of a metal sheet in which are punched holes of the proper size to permit beams of light to play directly on the several gauges. The rear face of the box is also a metal plate in which a slot is cut to permit a band of light to illuminate the deck.

In addition to this centralized light, the usual water glass lamp and the reading lamp for the engineer are provided so that only a pencil ray of light will strike the gauges. The interior of this lighting box is painted black. Any lighter color would evidently make for cross reflections through the hole provided in the covers and thus tend to illuminate the general space in the cab instead of concentrating the lights on the gauges. The location of special valves or other details on the boiler head, can advantageously be illuminated the same as the gauges.

The report is signed by W. E. Dunham (chairman), superintendent car department, Chicago & North Western; E. P. Chase, assistant engineer, Pennsylvania; H. A. Currie, electrical engineer, New York Central; E. Wanamaker, electrical engineer, Chicago, Rock Island & Pacific; E. W. Jansen, electrical engineer, Illinois Central; A. E. Voigt, engineer car lighting, Atchison, Topeka & Santa Fe; E. Lunn, electrical engineer, Pullman Company, and P. J. Callahan, supervisor locomotive and car electric lighting, Boston & Maine.

Discussion

W. E. Dunham (C. & N. W.): In connection with the development of axle generator drives, the committee has had several inquiries as to the limitations placed by the association in its 1922 report, and several of the developing concerns have rather criticized those statements, considering them as positive and absolutely required. Your committee wishes to repeat the fundamentals desired in a mechanical drive at this time, and in view of the suggestions made in that report of 1922. They are given here in this report just as they were in the 1922 report, being nine fundamentals.

Under the heading "Incandescent Lamp Schedule," we have been advised by the lamp people that there are some additions which should be made to the groupings of motor coach lighting service and electric street railway lighting service. With your permission these will be handed to the secretary to be included in the letter ballot. These additions are the result of the fast growing motor coach service, and the lighting of our trains getting into fields that a year or so ago were not even thought of. The lamp makers are keeping abreast of those situations, and we wish to include their recommended lamps in our list.

Mr. J. E. Bjorkholm (C. M., St. P. & P.): In connection with the particular train which is mentioned in the committee's report, we have experimented for some months past in lighting this train, which consists of some nine or ten cars, from the locomotive. On account of the peculiarities of this run, the engine laying over in Milwaukee about four hours each day, the engine cannot always be turned when it is due for tests, washouts and so forth, which presented certain difficulties because when the engine was held it was necessary to hunt up a dynamo baggage car to take the place of the engine to light the train. Therefore, we later mounted the dynamo on the tender. Our tenders are not carrying the number and, therefore, are easily interchangeable. When the engine is laid up for any purpose the tender is changed and we are constantly assured of being able to light the train from the locomotive.

I think perhaps it is rather early to say whether or

not this will prove successful. It is fair to say, however, that so far it has proven satisfactory. We have had no trouble whatever with it. The unit is a 20 kw. unit with a steam line tapped into the tender train heat line.

(*A motion to accept the report, referring certain portions to letter ballot, was carried.*)

Report on Locomotive Design and Construction

Counterbalancing——Booster Tractive Force——Pipe Fittings and Oil-Electric Locomotives Considered

W. I. Cantley
Chairman

Your committee has, during the year, given further consideration to the following subjects:

Standardization of Fundamental Parts of Locomotives. (Exhibit A.)

Standardization of Pipe Unions of the Nut and Nipple Type. (Exhibit B.)

Standardization of 300 lb. Screwed Pipe Fittings. (Exhibit C.)

The Development and Use of the Oil-Electric Locomotive in Railroad Service. (Exhibit D.)

Locomotive Boilers, with Special Reference to Firebox and Combustion Chamber Stays, Rectangular and Gussett Braces for Boiler Shell. (Exhibit E.)

Formula for Computing Tractive Effort of Locomotive Booster. (Exhibit F.)

Reports of the subcommittees on these subjects are contained in the accompanying Exhibits.

Exhibit A—Standardization of Fundamental Parts of Locomotives

The past year's work of the subcommittee has included the following subjects on which reports have been prepared:

1. Counterbalance of Locomotives. (Exhibit A-1.)
2. Brackets for Securing Air Pumps, Feed Water Heaters, Reverse Gears, etc., to Boilers of Locomotives. (Exhibit A-2.)
3. Pressures for Applying Steam Chest and Cylinder Bushings. (Exhibit A-13)

Other subjects, including Mounting Pressures for Locomotive Crank Pins and Axles, and Flange and Tread Contours of Locomotive Wheels, were also considered, but the committee required more time in which to complete its investigation.

Exhibit A-1—Counterbalancing of Locomotives

Your committee appointed to study and report on the subject of Counterbalances for Locomotives, respectfully submits these discussions and deductions. [The report which is quite complete will appear in a later issue of the Railway Mechanical Engineer. —Editor.]

The report of the subcommittee on counterbalancing is signed by S. S. Riegel.

Exhibit A-2—Brackets and Other Means of Support for Air Pumps, Water Pumps, Power Reverse Gears, Feedwater Heaters, etc.

In response to a circular letter replies were received from 31 railroads.

The questions asked in this letter were:

1. Send blueprints illustrating the designs that have given the best service.
2. Material from which the brackets are made.
3. Freedom from vibration, particularly in support of air pumps, is an important factor. Have cast brackets or built up brackets given better results in this regard?
4. Give any other information that experience indicates would be of value in the study of this subject.

The answers to the second question indicate that cast steel is the material in general use for brackets supporting these pieces of equipment. It is noted from print submitted, however, that the design in general use for air and feed pump brackets consists of a main bracket of cast steel in conjunction with steel plate or bar braces at the lower end.

Clearance restrictions combined with increasing boiler diameters have created the necessity of lowering feedwater and air pumps so as to get all possible advantage of the space under curve of the boiler shell. In designing brackets to fit into this space, it has been quite the practice to place the upper bracket studs below the horizontal center line of the boiler. Studs so placed have been the source of trouble because of the tension and bending stresses set up in them, causing them to leak. One road reported stopping leakage by increasing the number of studs in all their brackets. The usual stud arrangement is six $1\frac{1}{8}$ in. studs. Another road shows a design with ten $1\frac{1}{8}$ in. studs and are recommending taking feed and air pumps off the boiler to get away from broken and leaking studs.

From a study of the various designs sent in, and results reported, the upper studs for the brackets should be located on or above the center line of the boiler, in order to place the studs in shear only. In case the application does not permit a satisfactory design of casting to accomplish this, hangers of plate or bar steel can be employed advantageously to support the brackets.

Among the designs submitted is a patented design of bracket suspended by horizontal bolts from a hinge butt riveted to the boiler shell and anchored at the bottom by the usual plate brace to the belly of the boiler. This type appears to possess merit in that it provides flexibility and also that one bracket may be used for all locomotives. One hinge butt design will fit a variety of boilers. Two variations of the foregoing type, also patented, have a similar pump bracket, but use instead of the hinge pins, hanger brackets with bolting flanges to which the bracket is attached at the top. These designs also eliminate carrying a variety of brackets, as one bracket can be used for all locomotives, with the small hanger brackets only being varied to suit different boilers.

The underlying principle to be observed in the design of the top portion of these brackets, whether built up or cast, is, to get the supporting studs high enough on the boiler shell so that they are subjected to shearing stresses only.

The lower end of the pump bracket should be amply braced. One-piece cast steel brackets would often have to be made too heavy in order to extend the necessary distance under the belly of the boiler to form a good brace, particularly if it is necessary to hang the pump low. These lower braces are usually made of $\frac{3}{4}$ in. plate of about 11 in. width, fastened to the boiler with two or three studs and to the brackets with three or four bolts.

Reinforcement of this type of brace by application of angle or tee section stiffeners has helped in some cases. The main consideration in the application of these lower braces is to have the brace make as great an angle with the bracket as possible and possess ample rigidity.

Two roads have expressed satisfaction with bracket arrangements consisting of two straps studded to the boiler shell at and above the center line extending down to the bottom of the pump. These straps are braced at the lower end by a steel casting which forms a tie between the straps themselves and between the straps and the boiler shell. The pumps are held by turned bolts passing through both the straps and brace casting. This appears to be the best arrangement employing steel castings.

Replies show that built up brackets have been found to be both superior and inferior to cast steel brackets. Some roads have discarded castings for the built up type and others have done the reverse. It is noted that no road sent in any designs of brackets built up by welding, although several complained of built up brackets becoming loose. The best designs of built up brackets have auxiliary braces between the lower brace and the pump bracket.

The same principles of stud location and lower brace design apply to built up brackets as to the combination type.

One-piece brackets of cast steel are used by several roads, and the comments range from satisfactory to recommendations to remove pumps from the boiler. To avoid excessively heavy brackets, some designs concentrate the studs in a relatively small area on the shell, which results in trouble from leaking and broken studs.

Several replies contained recommendations that all heavy pumps be removed from the boiler and placed at the front-end of the frame. Users of brackets supported at the front of the frame are recommending that the brackets be cast integral with the front deck casting to secure more rigidity.

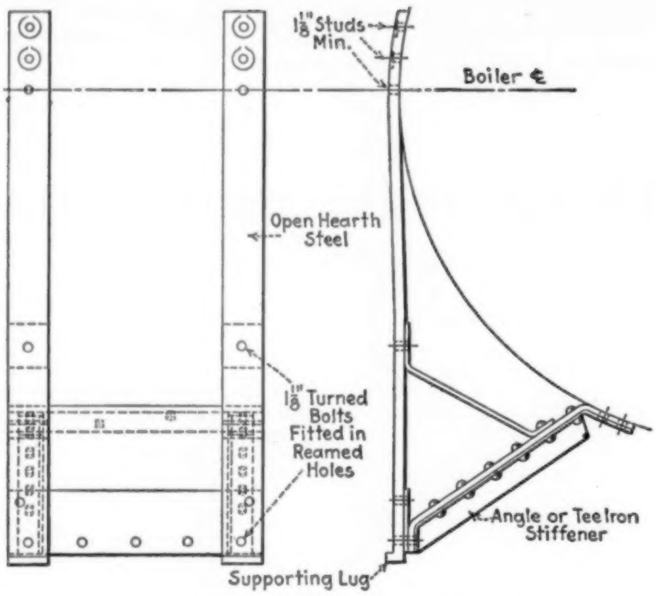


Fig. 1—Air-Pump and Feedwater-Pump Bracket, Built-up Type

Users of brackets mounted on the smokebox ring complain of loose bolts. Where there are apparently enough bolts, it might be well to ascertain if the smokebox front itself is properly stiffened to take care of the weight and vibration.

For smaller apparatus such as small pumps, reverse gears, etc., the conditions under which the application must be made will govern as to type of bracket and material used. In most cases the number of studs required in the boiler shell will not be enough to cause concern and the weights of the apparatus to be mounted not great enough to create severe stresses. It is felt, however, that one-piece cast steel brackets are most suitable in the majority of cases.

RECOMMENDATIONS

1. That brackets for attaching air pumps and reciprocating feedwater pumps to boilers of existing locomotives be made of steel plates or bars as shown in Fig. 1 or a combination of steel bars attached to a steel casting which forms the lower section for attachment of pump as shown in Fig. 2.

The upper studs for attaching the brackets to be located on or above the center line of boiler in order to place the studs in shear only.

The lower end of the pump bracket to be attached to the boiler by steel casting or plate or bar braces not less than ⅝ in. thick reinforced with angle or tee section stiffeners.

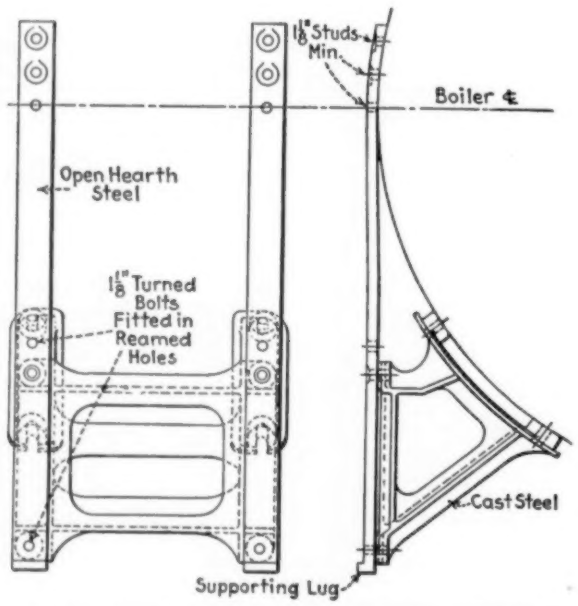


Fig. 2—Air-Pump and Feedwater-Pump Bracket with Cast-Steel Lower Portion

Braces to make as great an angle as it is possible to get with the bracket.

Pump to be attached to the brackets with turned bolts fitted in reamed holes where possible.

Brackets to have supporting lugs at bottom to take shear off bolts.

2. For new locomotives where conditions will permit, air pumps to be located at front end of frame on brackets attached to front deck casting.

3. Where necessary to locate air pumps on front of smokebox account of clearances, etc., the front plate of smokebox should be reinforced with angle or tee iron stiffeners to prevent vibration.

4. Brackets for the reverse gear, etc., are to be made preferably of cast steel with supporting lugs for attachment to boiler, spread as far apart as design will permit in order to give rigidity.

5. Where design will permit, it is recommended that straps extending across the top of boiler be used for supporting air reservoir and pipe brackets.

The report of the Sub-committee on Brackets is signed by S. Zwight.

EXHIBIT A-3—PRESSURES FOR APPLYING STEAM CHEST AND CYLINDER BUSHINGS

Your committee has made a survey among the major railroads of the United States and Canada and has the following report to make:

CYLINDER BARREL BUSHINGS

The various thicknesses of cylinder barrel bushings used by the various railroads reporting are as follows:

Thickness in.........	½	9/16	⅝	¾	1	1¼	1½
Roads Using........	2	1	9	23	2	1	1

It will be noted that cylinder barrel bushings applied by most railroads are ¾ in. in thickness and the committee feels that this is a reasonable thickness for all purposes.

It is the general practice of most roads to bush the barrels of new cylinders when machining them or applying them to locomotives. Some roads, however, follow the practice of bushing cylinders after the first period of wear. One road reports that the initial application of cylinder barrel bushings is made after the bore of the cylinder has been enlarged to the extent of ½ in. beyond its original diameter as the result of wear and reboring.

The majority of roads reporting follow the practice of applying cylinder barrel bushings by pressing them in. It appears, however, that a few follow the practice of heating the cylinders and shrinking them over the bushings. Some roads which follow the practice of pressing bushings into place at their principal repair shops make occasional use of the shrinkage process when it becomes necessary to apply bushings at outside points. When the shrinkage process is used, the cylinder is generally heated by a slow wood or charcoal fire, taking care that the heating is gradual and uniform. Other means of heating, such as blow torches burning fuel oil, are also employed on some roads. Five roads, which make a general practice of applying bushings by the shrinkage method, report no trouble therefrom, while most of the roads using the pressed-fit method of applying report having formerly used the shrinkage method with considerable trouble, due to cracked cylinders and difficulty when attempting to apply bushings to patched cylinders by the shrinkage method.

Cylinder barrel bushings on some roads are made straight and of the same outside diameter throughout their entire length. The majority of the roads, however, make the outside diameter of the rear half of the bushing slightly smaller than the forward half, thus producing what is known as a step-fit, as shown by Fig. 1. The step-fit has the advantage of reducing by one-half the distance through which the bushings must travel when being pressed into position. It has the further advantage of reducing the cost of making and applying bushings by virtue of the fact that the forward port only need be cut in the bushing, and it is made possible to renew a bushing without disturbing the back cylinder head or guides.

The tonnage under which cylinder barrel bushings should be applied is specified by some roads, but since it is difficult to build a portable hydraulic press that will give accurate readings, and since most roads in applying bushings by the pressed-fit method use power-driven screws or other mechanical devices which do not afford data as to the tonnage exerted, the committee feels that it is preferable to specify oversize or pressed-fit allowances, instead of mounting pressures. Data obtained from the various roads indicates that a press fit allowance of .00025 in. per inch of diameter gives satisfactory results for bushings up to 40 in. diameter.

Taper threaded plugs (usually two per bushing), as shown in Fig. 1, are almost universally used for securing cylinder barrel bushings against circumferential movement. Longitudinal movement is, in some cases, prevented by contact between the ends of the bushing and the front and back cylinder heads, or

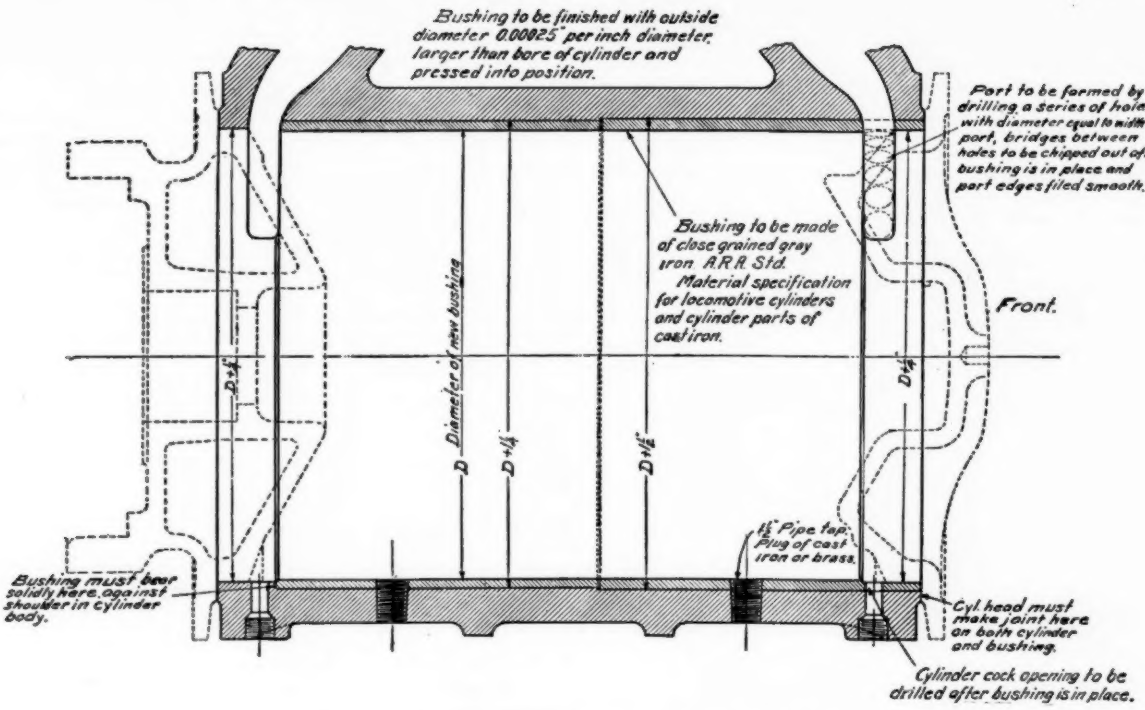


Fig. 1—Recommended Cylinder-Barrel Bushing

by contact with the front cylinder head at one end and a shoulder in the bore of the cylinder at the other end, if application is made in accordance with Fig. 1.

Cylinder barrel bushings are, in practically all cases, made of a close-grained grey iron mixture.

A lubricating mixture, consisting of white lead and linseed oil, is usually applied to the exterior of cylinder barrel bushings when they are being pressed in. This mixture consists of 12 to 16 lb. of white lead per gallon of oil. Either raw or boiled linseed oil may be used.

Steam Chest Bushings

The majority of the roads reporting use steam chest bushings of the general design shown in Fig. 2. The thicknesses of bushings used by these roads are as follows:

Thickness in...........	½	⅝	¾	⅞	1	1⅛	1¼
Roads Using...........	4	16	18	2	2	1	1

It is desirable to make steamchest bushings thick enough to withstand distortion resulting from heat or pressure applied in application, but on the other hand it should be remembered that the thicker the bushing, the greater becomes the cylinder clearance. It will be noted, from the foregoing tabulation, that a majority of the roads make steam chest bushings ¾ in. thick, and the committee feels that this is a reasonable thickness for all purposes.

Practically all roads follow the general practice of pressing steam chest bushings into position. One road, however, which used the shrinkage method of applying cylinder barrel bushings, reports that if new steam chest bushings are required at the time of applying new cylinder barrel bushings, steam chest bushings, as well as barrel bushings, are applied by shrinkage and at the same heat.

Some roads specify the tonnage which should be required to press steam chest bushings into the cylinders, these pressures being, in practically all cases, considerably higher than those given by the same roads for cylinder barrel bushings. For the reasons given in connection with cylinder barrel bushings, the

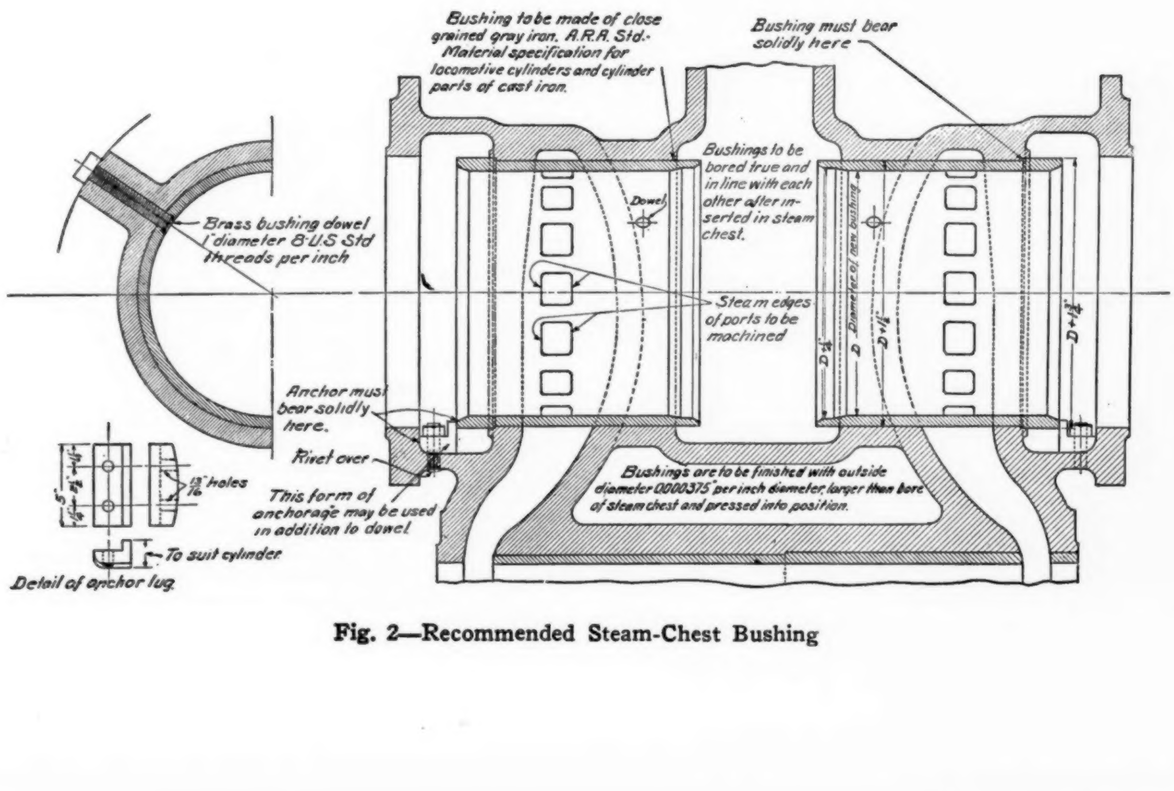


Fig. 2—Recommended Steam-Chest Bushing

committee feels that it will be preferable to specify oversize or pressed-fit allowances to govern the application of steam chest bushings. Information received indicates that a pressed-fit allowance of .000375 in. per inch of diameter gives good results for all steam chest bushings of ordinary size.

Practically all steam chest bushings are made of the same grey iron mixtures that are in use for cylinder barrel bushings.

The lubricating mixture of white lead and linseed oil, described in connection with cylinder barrel bushings, is also used in applying steam chest bushings.

Steam edges of ports are machined by all roads reporting. Generally this work is done on a milling machine, but a few follow the practice of cutting grooves in the bushing to locate the steam edges of the ports, which are finally finished throughout the entire thickness of the bushing by chipping and filling. The committee feels that the practice of milling the ports of steam chest bushings is preferable.

Practically all roads follow the practice of anchoring steam chest bushings in position by inserting a threaded plug or dowel, usually 1 in. diameter, as shown in Fig. 1, through the wall of the steam chest, as well as through the bushing. This dowel is usually made of brass. Some roads, particularly those operating in bad weather territories, have found this form of anchorage to be inadequate to prevent longitudinal displacement bushings in service, and have come to rely upon the threaded dowel to prevent circumferential movements only. One road supplements the threaded dowel by the application of a block inserted between the end of the bushing and the end wall of the steam chest, as shown in Fig. 2. Other roads extend the bushings to the end of the steam chests so that the steam chest head can be applied in contact with the end of the bushing, as shown in Fig. 3. Since the

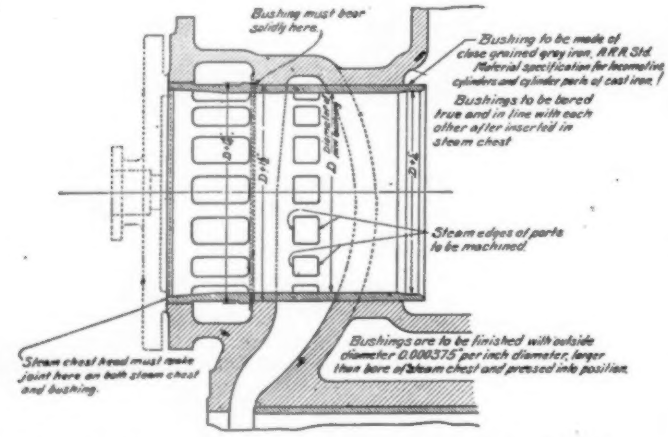


Fig. 3—Optional Steam-Chest Bushing in Contact with Head

majority of roads find the threaded dowel of Fig. 2 provides adequate anchorage, the committee has arranged its drawings to show this dowel as the preferred form of anchorage against both circumferential and longitudinal movements. The committee feels, however, that the additional means of anchorage, above referred to, are of sufficient value to warrant showing and recommending them as optional anchorages to be used in addition to the threaded dowel.

Recommendations

As result of its investigations, the committee makes the following recommendations:

(a) That new cylinders be equipped with barrel and steam chest bushings at, or prior to, the time of application to the locomotive.

(b) That cylinder barrel and steam chest bushings be pressed into cold cylinders, suitable oversize or pressed-fit allowances being made to insure tight fits.

(c) That steam edges of ports in steam chest bushings be accurately finished by milling.

(d) That cylinder barrel bushings be made and applied in accordance with Fig. 1.

(e) That steam chest bushings be made and applied in accordance with Fig. 2, except that bushings in accordance with Fig. 3 may be applied, if desired, to provide firmer anchorage against longitudinal movements or to provide for long valve travel with minimum length of steam chest.

The report of the sub-committee on Pressures for Applying Bushings is signed by E. C. Anderson.

The foregoing reports on Standardization of Fundamental Parts of Locomotives is signed by H. H. Lanning, J. C. Hassett, S. S. Riegel, E. C. Anderson, S. Zwight and W. I. Cantley.

Exhibit B—Standardization of Pipe Unions of Nut and Nipple Type

The report of this Committee was submitted to the convention at Los Angeles in July last year, with recommendations that these designs and proposed specifications be submitted to the Committee on Specifications and Tests of Materials and to the Committee on Car Construction. The report was accepted.

Since last year's convention some corrections and slight changes have been made and an up-to-date set of drawings is part of this year's report. (Drawings are omitted in this abstract —Editor.)

The Committee on Specifications and Tests of Materials has prepared a specification which will be submitted as part of their report.

The Car Construction Committee and Air Brake Committee are considering the adoption of these fittings for cars but will not be able to make recommendations for another year. In the meantime, there appears to be no reason why the designs and specification cannot be approved and voted upon this year for their use upon locomotives and the report is now ready for action.

The report of the sub-committee on Pipe Unions is signed by R. M. Brown (chairman), W. I. Cantley and S. S. Riegel.

Exhibit C—Standardization of 300-lb. Screwed Pipe Fittings for Locomotives

Last year it was suggested by this committee that standard drawings for 300-lb. screwed pipe fittings be prepared.

This committee has given this subject attention and finds that the Manufacturers' Standardization Society of the Valve and Fitting Industry is considering standard designs for 300-lb. working steam pressure. To date they have not yet adopted nor agreed upon a standard.

It is recommended that we continue another year working with the Manufacturers' Standardization Society of the Valve and Fitting Industry to see if we cannot arrive at standard dimensions and specifications which will be agreeable to all and be prepared to submit same to the convention next year.

The report of the subcommittee on Standardization is signed by R. M. Brown (chairman), W. I. Cantley, and S. S. Riegel.

Exhibit D—The Development and Use of Oil-Electric Locomotive in Railroad Service

The oil-electric locomotives seem to be gaining in favor and usefulness, particularly on roads where their use is confined to the service for which they are best suited, i. e., shifting service where the absence of smoke and noise is necessary. They have not, however, reached their final state of usefulness and some of the best minds in the mechanical world are at work on this problem.

With this thought in mind, it was the judgment of your committee that this year's report should consist simply in listing the various locomotives built and giving a little data in regard to the same. Such a list is appended hereto.

Recommended Action—That this progress report be received, as it is intended, as information only.

Recommendation for Future Work—That the study of the subject be continued, collecting data with a view of making a report, which will include performance and operating costs in different kinds of service.

The report of the subcommittee on Oil-Electric Locomotives is signed by H. A. Hoke (chairman), C. E. Brooks, and L. A. Richardson.

Exhibit E—Locomotive Boilers

Your subcommittee appointed to make a report on Maximum Stresses—Locomotive Boilers, with special reference to firebox and combustion chamber stays, round, rectangular and gusset braces for boiler shell, submit the following:

Metallurgists are constantly employed in providing improved materials for use in economically meeting the more and more exacting demands of present day railroad and other service requirements.

Such materials have been developed and are being used in locomotive boiler shell structures, and in both firebox and combustion chamber stays, round, rectangular and gusset braces for stayed surfaces of the boiler shell which materials have been found suitable in service when employed in designing boilers of higher steam pressures.

These materials, using the same cross sectional areas will sustain higher stresses per square inch than the materials previously employed, and when used in the construction of boilers mean that for equal weights of material higher steam pressure can be obtained.

Railroads have been able to take advantage in this reduction of weight in the shells of boilers since the Interstate Commerce Commission Rules determining the boiler strength are based on factors of safety.

When the present I. C. C. Rules governing the stresses and factors of safety for locomotive boilers were adopted the allowable maximum stresses consisted of 7500 lb. per sq. in. of cross sectional area for firebox and combustion chamber stays based on tensile strength of wrought iron of 45,000 lb. per sq. in., this provides a factor of safety of six and the maximum allowable stress per square inch of 9000 lb. for round, rectangular or gusset braces, which gives a safety factor of five.

Therefore, it would seem entirely logical, just, and consistent with safety that the benefits of the higher strength materials be utilized by amending of the I. C. C. Rules, allowing railroads the minimum factor of safety of six for firebox and combustion chamber stays and five for round, rectangular and gusset braces based on the strength of the material used.

The proposed rule is as logical in all respects as the existing rule for the factor of safety of the shell sheet in boilers, whereby the railroads are enabled to take advantage of higher strength materials for boiler construction.

It is therefore recommended that the Interstate Commerce Commission be requested to amend the rules governing the maximum stresses for locomotive boilers for a minimum factor of safety of six for firebox and combustion chamber stays, and

Tabulation and Specifications of Oil-Electric Locomotives

	No.	Builder Loco.	Owner	Builder Engine	Builder Elect.	H.P.	Total Weight Loco.	Weight per H.P. Engine only	Weight per H.P. Total	Cylinder No. and Size D & S.	Cycles	Fuel Injection	R.P.M. Engine	Wheel Arrangement	Date in Service
1	1	B. L. W..	B. L. W.........	B. L. W..	West..	1000	275,000	45	275	12 – 9¾" x 13½"	2	Solid	450	0-6-6-0	1925
2	1	A. L. Co..	C. R. R. of N. J...	I. R.....	G. E..	300	122,000	67	406.7	6 –10" x 12"	4	"	550	0-4-4-0	1925
3	1	"	L. I. R. R......	I. R....	G. E..	600	202,000	67	336.7	6 –10" x 12"	4	"	550	0-4-4-0	1925
4	1	"	B. & O. R. R....	I. R....	G.	300	122,000	67	406.7	6 –10" x 12"	4	"	550	0-4-4-0	1925
5	1	"	L. V. R. R......	I. R......	G. E.	300	122,000	67	406.7	6 –10" x 12"	4	"	550	0-4-4-0	1926
6	2	"	C. & N. W. R. R..	I. R.....	G. E.	300	132,000	67	440.0	6 –10" x 12"	4	"	550	0-4-4-0	1926
7	1	"	Erie............	I. R.....	G. E..	300	132,000	67	440.0	6 –10" x 12"	4	"	550	0-4-4-0	1926
8	1	"	P. & R. R. R....	I. R.....	G. E..	300	132,000	67	440.0	6 –10" x 12"	4	"	550	0-4-4-0	1926
9	2	"	D. L. & W. R. R.	I. R.....	G. E..	300	132,000	67	440.0	6 –10" x 12"	4	"	550	0-4-4-0	1926
10	1	"	Utah Copper...	I. R.....	G. E.	300	132,000	67	440.0	6 –10" x 12"	4	"	550	0-4-4-0	1926
11	1	"	Red River Lumber Co...........	I. R.....	G. E..	600	214,000	67	356.7	6 –10" x 12"	4	"	550	0-4-4-0	1926
12	1	"	I R. Co.... ...	I. R.....	G. E..	300	132,000	67	440.0	6 –10" x 12"	4	"	550	0-4-4-0	1926
13	1	"	G. N. R. R......	I. R.....	G. E..	600	214,000	67	356.7	6 –10" x 12"	4	"	550	0-4-4-0	1926
14	1	"	C. & N. W. R. R..	I. R......	G. E..	300	132,000	67	440.0	6 –10" x 12"	4	"	550	0-4-4-0	1927
15	1	Brill....,	L. V. R. R......	Mc. & S..	G. E..	300	146,000	67	486.7	12 – 8" x 9½"	4	Air...	550	0-4-4-0	1927
16	1	A. L. Co..	Union Carbide...	I. R.....	G. E..	300	134,000	67	466.7	6 –10" x 12"	4	Solid..	550	0-4-4-0	1927
17	2	"	Erie............	I. R.....	G. E..	600	230,000	67	383.3	6 –10" x 12"	4	"	550	0-4-4-0	1927
18	1	"	American Rolling Mill Co........	I. R.....	G. E..	300	148,000	67	493.3	6 –10" x 12"	4	"	550	0-4-4-0	1927
19	1	"	P. & R. R. R....	I. R.....	G. E..	300	132,000	67	440.0	6 –10" x 12"	4	"	550	0-4-4-0	1928
20	1	"	American Rolling Mill Co........	I. R.....	G. E..	600	214,000	67	356.7	6 –10" x 12"	4	"	550	0-4-4-0	1928
21	1	"	Donner Steel Co.	I. R.....	G. E..	300	134,000	67	446.7	6 –10" x 12"	4	"	550	0-4-4-0	1928
22	1	"	A. Roll. Mill Co..	I. R.....	G. E..	300	148,000	67	493.3	6 –10" x 12"	4	"	550	0-4-4-0	1928
23	1	"	N. Y. C. R. R...	I. R.....	G. E..	750	290,000	60	386.7	6 –14¾" x 16"	4	"	500	4-8-4	1928
24	1	"	N. Y. C. R. R...	Mc. & S..	G. E..	880	361,000	90	410.2	12 –14" x 18"	4	Air...	300	4-8-4	1928
25	1	"	N. Y. C. R. R...	I. R.*....	G. E..	300	257,000	67	*856.7	6 –10" x 12"	4	Solid	550	0-4-4-0	1928
26	1	"	L. I. R. R.......	I. R......	G. E..	600	212,000	67	353.3	6 –10" x 12"	4	"	550	0-4-4-0	1928
27	1	"	Erie............	I. R.....	G. E..	300	132,000	67	440.0	6 –10" x 12"	4	"	550	0-4-4-0	1928
28	1	"	Donner Steel Co.	I. R.....	G. E..	300	134,000	67	446.7	6 –10" x 12"	4	"	550	0-4-4-0	1928
29	1	G. E.....	Hoboken Term...	I. R.....	G. E..	300	144,000	67	480.0	6 –10" x 12"	4	"	550	0-4-4-0	1928
30	1	G. E.....	Hoboken Term...	I. R.....	G. E..	600	220,000	67	366.7	6 –10" x 12"	4	Solid	550	0-4-4-0	1928
31	1	B. L. W..	L. I. R. R.......	West.....	West..	600	174,000	20.2**	290.0	6 – 8¼" x 12"	4	"	800	0-4-4-0	1928
32	2	A. L. Co..	Donner Steel Co.	I. R......	G. E..	300	134,000	67	446.7	6 –10" x 12"	4	"	550	0-4-4-0	1929
33	1	G. E.....	I. C. R. R.......	I. R......	G. E..	600	220,000	67	366.7	6 –10" x 12"	4	"	550	0-4-4-0	1929
34	1	B. L. W..	W. E. & M. C....	West.....	West..	300	111,000	20.2**	370.0	6 – 8¼" x 12"	4	"	800	0-4-4-0	1929
35	1	"	A. Roll. Mill Co..	West.....	West..	300	149,000	20.2**	496.7	6 – 8¼" x 12"	4	"	800	0-4-4-0	1929
36	1	G. E.....	Foley Bros......	I. R.....	G. E..	600	220,000	67	366.7	6 –10" x 12"	4	"	550	0-4-4-0	1929
37	1	A. L. Co..	Buffalo G. E.....	I. R.....	G. E..	300	134,000	67	446.7	6 –10" x 12"	4	"	550	0-4-4-0	1929
38	1	B. L. W..	West. Elec.......	West.....	West..	300	116,000	20.2**	386.7	6 – 8¼" x 12"	4	"	800	0-4-4-0	1929
39	1	"	B. L. W.........	Krupp...	West..	1000	270,000	42	270.0	6 –15" x 15"	4	"	500	0-4-4-0	1929
40	5	G. E.....	I. C. R. R.......	I. R.....	G. E..	600	220,000	67	366.7	6 –10" x 12"	4	"	550	0-4-4-0	1930
41	2	A. L. Co..	A. Roll. Mill.....	I. R.....	G. E..	300	148,000	67	493.3	6 –10" x 12"	4	"	550	0-4-4-0	1930
42	1	G. E.....	Ford Motor Co..	I. R.....	G. E..	300	144,000	67	480.0	6 –10" x 12"	4	"	550	0-4-4-0	1930
43	1	"	Ford Motor Co..	I. R.....	G. E..	600	220,000	67	366.7	6 –10" x 12"	4	"	550	0-4-4-0	1930
44	35	"	N. Y. C. R. R...	I. R*....	G. E..	300	256,000	67	853.3	6 –10" x 12"	4	"	550	0-4-4-0	Under Const.
45	2	Can.L.W.	C. N. Ry........	Beard-more...	West..	1520	334,000	22.9	219.7	12 –12" x 12"	4	"	800	4-8-2	Under Test.
46	1	G. E.....	Erie............	I. R......	G. E..	800	230,000	51	287.5	6 –14¾" x 16"	4	"	500	0-4-4-0	Under Const.
47	2	Whitcomb	C. M. St. P. & P.	Waukesha	West..	600	180,000	....	266.0	6 – 7¾" x 8½"	....	....	1200	0-8-0	1930
48	1	G. E.....	N. Y. C.........	I. R.....	G. E..	300	256,000	67	853.3	6 –10" x 12"	4	"	550	0-4-4-0	
49	4	"	M. C. R. R......	I. R.....	G. E..	300	256,000	67	853.3	6 –10" x 12"	4	"	550	0-4-4-0	
50	1	"	C. R. I. & P.....	I. R.....	G. E..	300	256,000	67	853.3	6 –10" x 12"	4	"	550	0-4-4-0	
51	1	Can.L.W.	C. N. Ry........	West.....	West..	450	120,000	23.1	266.7	6 – 9" x 12"	4	"	1000	0-8-0	Under
52	2	B. L. W..	G. Lake Steel....	West.....	West..	300	140,000	20.2**	466.7	6 – 8¼" x 12"	4	"	800	0-4-4-0	Const.
53	1	"	A. St. & Wire Co.	West.....	West..	400	140,000	18.2**	350.0	6 – 9" x 12"	4	"	900	0-4-4-0	
54	2	"	Westinghouse....	West.....	West..	400	140,000	18.2**	350.0	6 – 9" x 12"	4	"	900	0-4-4-0	
55	1	"	Westinghouse....	West.....	West..	800	220,000	18.2**	275.0	6 – 9" x 12"	4	"	900	0-4-4-0	
56	2	G. E.....	D. L. & W. R. R.	I. R*....	G. E..	300	248,000	53.	826.7	6 –10" x 12"	4	"	550	0-4-4-0	

*Oil-Electric Storage Battery Engine.

**Not including weight of flywheel and bed plate.

factor of safety of five for round, rectangular and gusset braces, based on the known tensile strength of the materials used.

The report of the subcommittee on Locomotive Boilers is signed by George H. Emerson (Chairman), A. H. Fetters and S. S. Riegel.

Exhibit F—Formula for Computing Tractive Force of Locomotive Boosters

Since the last report of the subcommittee on Formula for Computing Tractive Effort of Locomotive Boosters questions have been raised relative to the tractive effort of boosters with shorter cut-off, which are now in use. The subcommittee has investigated the matter and recommends that the present formula for Booster Tractive Force be amended to read as follows:

$$T = \frac{CPdSr}{D}$$

when

T—Tractive effort of booster.
C—Ratio M. E. P. in cylinder to boiler pressure and is
0.80 for 75 per cent cut-off boosters.
0.73 for 50 per cent cut-off boosters.
0.774 for 70 per cent cut-off boosters.
P—Boiler pressure, lb. per sq. in.
d—Dia. of cylinder in inches.
S—Stroke of piston in inches.
D—Diameter of booster driving wheels in inches.
r—Gear ratio.

The report of the subcommittee on Tractive Effort is signed by A. H. Fetters, Geo. McCormick and R. M. Brown.

The report of the Committee on Locomotive Design and Construction is signed by W. I. Cantley (Chairman), mechanical engineer, Lehigh Valley; H. H. Lanning (Vice-Chairman), mechanical engineer, Atchison, Topeka & Santa Fe; H. A. Hoke, assistant mechanical engineer, Pennsylvania; G. McCormick, general superintendent, motive power, Southern Pacific; J. C. Hassett, mechanical engineer, New York, New Haven & Hartford; E. C. Anderson, mechanical engineer, Chicago, Burlington & Quincy; W. G. Black, mechanical assistant to president, Chesapeake & Ohio; C. E. Brooks, chief motive power, Canadian National Railways; G. H. Emerson, chief motive power and equipment, Baltimore & Ohio; A. H. Fetters, general mechanical engineer, Union Pacific; S. Zwight, general mechanical superintendent, Northern Pacific; R. M. Brown, superintendent motive power, New York Central; H. M. Warden, mechanical superintendent Missouri-Kansas-Texas; S. S. Riegel, mechanical engineer, Delaware, Lackawanna & Western; and L. A. Richardson, general superintendent motive power, Chicago, Rock Island & Pacific.

Discussion

Vice-Chairman Ayers: Mr. Cantley feels, and I agree, that it is better to take this report in sections. The Counterbalance section, now before you, is a wonderful treatise on that subject. I don't remember having read a more far reaching analysis of it, and I hope the discussion will develop how far any of you have been using these methods and what success you have had.

J. A. Pilcher (N. & W.): The method of counterbalance that has been discussed is one that would be found desirable in very large engines where it is necessary to spread the cylinder centers and where it is difficult to get in the effective amount of balance. You will notice in the discussion that they not only attempt to balance simply the parts to be considered rotating in the same plane but this cross-balancing and angling of the counterbalancing is brought about in an attempt to balance such parts because the weights are rotating in different planes.

H. H. Lanning (A. T. & S. F.): In 1924 our first locomotive was cross-counterbalanced and since that time 89 others, making a total of 90, have been similarly treated. That is, they have been cross-counterbalanced in the main driving wheels only.

The tests of rail stresses which have been made by representatives of the University of Illinois, and also, by our road, have confirmed experimentally the figures given in the table by Mr. Riegel. The 1915 and previous methods of counterbalancing were satisfactory for locomotives that were built at that time. Driver loads of 40,000 and 60,000 lb. prevailed and gave a wide margin between strength of track and loads imposed upon tracks and bridges by the moving locomotives.

Conditions have greatly changed since then. Locomotives built now must move more cars and move them a great deal faster. Locomotives with driver loads of 70,000 lb. or more have been and are being built. It was mentioned yesterday that locomotives averaging 71,000 to 72,000 lb. were in service. In most cases these locomotives are running over heavier rails than those used in 1915, but in many instances they are running, of necessity, over the same bridges, with some reinforcement in the bridges, of course. These larger locomotives have either larger cylinders or higher boiler pressure, but in either case the crank pins are larger and longer and the weights of the rods and the counterweight revolve in different planes.

Counterweights and crank pins have increased in size with the increase in size of locomotives, and the safe margin which we had in 1915 between the load and the strength of the track is disappearing. We must do something more than avoid excessively heavy moving parts. By refinements such as reduction in weight of moving parts, in addition to cross-counterbalancing, we have been able to convince our bridge engineers that more weight can be safely carried per pair of driving wheels.

Lawford H. Fry (Edgewater Steel Company): Your committee has presented a very interesting and useful paper on cross-counterbalancing. A knowledge of the advantages of cross-counterbalancing is not new, but it is coming into importance at the present time because of the increasing size of locomotives. Over 25 years ago some of the early four-cylinder balanced-compound locomotives demonstrated in service that that type of locomotive could not be run without cross-balancing.

The present revival of the practice goes back, I think, about six years. At that time the Santa Fe cross-balanced a 2-10-2 type locomotive, their number 3890. Mr. Ripley's report to the Association in 1926 described the tests and showed how cross-balancing had reduced track stresses materially. The results obtained were given a practical application a year or two later. More powerful locomotives were wanted, and the weight limits set by the bridge engineer had been reached. The problem of producing heavier power was, therefore, difficult. The solution was found in the use of cross-counterbalancing. The bridge engineer recognized that proper balancing would reduce the hammer blow on the rail, and therefore allowed the static weight to be increased if cross-balancing were used.

In considering the question of balance it must be remembered that cross-counterbalancing has its limitations. It cannot avoid the hammer blow coming from the balance put in to take care of the reciprocating parts. Its function is to give complete counterbalance for the rotating parts. By the ordinary method of balancing, the parts which are supposed to be correctly balanced may be as much as 400 lb. out of balance at crank pin radius, and this will give at diameter speed a hammer blow of about 8000 lb. per wheel, or about 11,000 lb. per axle. This can be avoided by cross-balancing if the diameter of the wheel is large enough to give room for the necessary balance and weight. In the case of a small-wheeled locomotive it may be necessary to go to a light alloy main rod to obtain complete balance.

Another point which the committee might consider further is the amount of reciprocating weight which can be left unbalanced without making the locomotive ride badly. The committee speaks of the percentage of reciprocating parts which are left unbalanced. This does not tell the whole story. The important relation is that

between the unbalanced reciprocating parts and the weight of the locomotive.

The force tending to shake the locomotive depends on the weight of the unbalanced reciprocating parts. The force tending to resist this shaking depends on the mass of the whole locomotive. Consequently, a light locomotive with heavy reciprocating parts may ride badly, although you balance 50 per cent of the weight of the parts.

On the other hand, a heavy locomotive with light reciprocating parts may ride well with only ten per cent of the parts balanced.

I think it would be desirable for the committee to study this matter and to show the relation which should obtain between the weight left unbalanced and the total weight of the locomotive. This idea was suggested about 20 years ago by George R. Henderson.

It is quite possible that in the future with heavy locomotives and light alloy main rods it may be possible to leave practically all of the reciprocating parts unbalanced, and by cross-balancing reduce the hammer blow to a negligible quantity.

This may be visionary, but the committee's report deals with a condition and not a theory, and it offers a means of securing more powerful locomotives without increasing the stress on the track.

(*Discussion on Counterbalancing Was Closed*)

Mr. Cantley: I will ask Mr. Zwight to present the next report on "Brackets and other Means of Support for Air Pumps, Water Pumps, Power Reverse Gears, Feedwater Heaters, etc. on Locomotives".

S. Zwight (N. P.): Before reading the report I will state that inasmuch as it was well known that many roads have experienced considerable difficulty with broken studs a questionnaire was sent out to ascertain the practices followed what had been done to overcome the difficulty, and what recommendations were to be given for the guidance of others. This report is based on the replies that we received.

Among the illustrations of hangar and lugs referred to, there is no cut of the hinge butt for the reason that it is a patented device and we thought it wasn't desirable. I understand the patent is held by the Baldwin Locomotive Works and undoubtedly they will be glad to encourage its use wherever it can be used to advantage.

(*There was no discussion on Brackets.*)

Applying Steam Chest and Cylinder Bushings

[The subcommittee report on Pressures for Applying Steam Chest and Cylinder Bushings was presented by Mr. Lanning. There was no discussion.]

Standardization of Pipe Unions

(The subcommittee report on Standardization of Pipe Nipple Unions of the Nut and Nipple Type and the report on Standardization of 300-lb. Screwed Pipe Fittings for use upon Locomotives was presented by R. M. Brown. There was no discussion.)

Oil-Electric Locomotives

(The sub-committee report on the Development and Use of the Oil-Electric Locomotive in Railroad Service was presented by C. E. Brooks. There was no discussion.)

Locomotive Boiler Details

(The sub-committee report on Locomotive Boilers with Special Reference to Firebox and Combustion Chamber Stays, Rectangular and Gusset Braces for Boiler Shell, was presented by Mr. Fetters.)

C. E. Brooks (C. N.): I don't think that those of us who have had experience with steel staybolts and with high tensile boiler steels should miss this opportunity of telling you that you don't need to believe all the warnings that are published in advertisements and various mechanical magazines tending to keep you from the use of steel staybolts.

The railroad to which I belong went to the use of steel staybolts in 1920, which is ten years ago. We don't buy a single iron staybolt and I might say that today,—I can't attribute this entirely to the use of the steel staybolts,—but today our staybolt consumption is less than half what it was several years ago. Our breakages are nothing to indicate a dangerous character existing in boilers up to 275 lb. pressure. We build boilers with 275 lb. of steam without any flexible bolts in them, all steel hollow bolts.

The suggestion that has been made by the committee that the higher tensile strength of these stays should be given consideration and also the higher strength which we now have to use for the stays other than actual staybolts should be given higher strength is something I believe every railroad man should stand behind.

Mr. Lanning: Mr. Brooks has said most of the things I meant to say, but I merely wish to point out that the hardest job of the mechanical engineer generally, is to build a locomotive that will do what is expected of it and not damage the track and bridges. That means he has to make it as light as he can to do the work intended of it.

When we design boilers to carry 275 or 300 lb. pressure or more and take up staying the firebox, we find that staybolts increase the weight of the boiler enormously. Furthermore we find that our boiler inspector tells us that when staybolts are subject to a high-pressure they are liable to damage by reason of progressive fracture. Then we are confronted with one of two things, either we must disregard the boiler inspector or put in larger bolts.

The only way out I see is that we be permitted to use higher tensile strength material in our staybolts and take advantage of making our bolts smaller confining ourselves to a reasonable factor of safety.

Tractive Effort of Boosters

[The sub-committee report on Formula for Computing Tractive Effort of Locomotive Boosters was presented by Mr. Fetters.]

New Motive Power (4-8-4 Type) on the Chicago & North Western

Vice Chairman Ayers: There is a formula already on the books for the tractive power of the booster. This is a recommendation to change it, and should go to letter ballot.

Mr. Purcell: In moving that the report be accepted, I would like to suggest that the committee add to the subjects to be discussed next year one on Track Stresses. That is one of the most important subjects we have before us at this time.

(The motion was duly seconded and carried.)

Report of Committee on Electric Rolling Stock

Locomotive ratings made comparable——Performance of regenerative braking shown——Heating apparatus for passenger cars described and compared

R. G. Henley
Chairman

The major part of the report consists of four exhibits prepared by four subcommittees on the following subjects: Standard Method of Rating Electric Locomotives; Regenerative Braking of Heavy Tonnage Trains; Heating Apparatus for Passenger Equipment used on Electrified Lines; Electric Locomotives Placed in Service for the Year Ending June, 1930.

Standard Method of Rating Electric Locomotives

The report of the subcommittee dealing with the subject of locomotive rating is herewith presented in full:

The problem of determining a standard method of rating electric locomotives is considered to be of major importance, but has proved to be a difficult one to answer satisfactorily. At present, various ratings are used for electric locomotives, and as these are arrived at in different ways there is no uniformity when comparing data on different locomotives. The ratings are used principally for the purpose of making general comparisons of the performance ability of different locomotives and are not sufficient for determining the ability of locomotives to handle prescribed work under specified conditions. For this purpose a great deal of exact engineering data are required. It is, therefore, thought that for the purpose in mind, i. e., of providing a means of general comparison among different locomotives, a closely approximate method of giving ratings will be satisfactory.

The horsepower, speed and torque at the motor shafts under given conditions of motor voltage, ventilation, temperature rise, etc., may be determined accurately by stand test. There is, however, the factor of locomotive machinery friction which reduces these results before they reach the wheel rims. To cover these losses, an arbitrary allowance of 3 per cent is recommended, as providing accuracy within a few per cent when applied to the various types of drive in use. Single reduction gear losses, when gears are used, are estimated to vary from 2.5 per cent at one hour motor rating, to 3 per cent at 150 per cent of one hour rating, and 2.7 per cent at 50 per cent of one hour rating. With a single-geared locomotive, a 3 per cent allowance is therefore practically correct. With a gearless locomotive the recommended method would give figures about 3 per cent low. With a gear and side rod locomotive, where the rod losses have never been determined, but are estimated as about equal to the gear losses, the figures would be 3 per cent or 4 per cent high. Such results are considered to be entirely suitable for the purpose. They would be comparable to, and considerably more accurate than, the "tractive power" of a steam locomotive when figured by the usual formula:

$$T = \frac{.85\ P\ C^2\ S}{D}$$

Where: T = Tractive force, pounds.
P = Boiler pressure, pounds.
C = Cylinder diameter, inches.
S = Stroke, inches.
D = Driver diameter, inches.

Where accurate test data are available, it may be used instead of the recommended method, and percentage allowance indicated.

There is considerable diversity among the methods of giving data on electric locomotives in various reports. By determining standard methods of rating for use in the table of locomotive data prepared by this Committee, reasonably accurate comparison among different locomotives may be made, and the results will be consistent and on a known basis. It is, therefore, recommended as follows:

(1) Electric locomotive ratings shall be considered as at the rims of the drivers, with locomotive on tangent, level track, and at constant speed.

(2) The locomotive ratings shall be:
(a) Maximum start.
(b) One hour.
(c) Continuous.

(3) At each of these ratings, the following data shall be given:
(a) Speed in miles per hour.
(b) Tractive force in pounds.
(c) Horsepower, determined by the formula:

$$\text{H. P.} = \frac{\text{Miles per hour} \times \text{Tractive force}}{375}$$

(4) The locomotive ratings shall be based on motor shaft ratings for maximum start (except as noted in 7b) for one hour and continuously with motors operating at the rated voltage. The one-hour motor ratings shall be determined with the motors starting cold. An arbitrary reduction of 3 per cent in motor torque shall be made when determining tractive effort, to compensate for mechanical losses, unless test data are available as noted above.

(5) The motor shaft ratings shall be determined by stand tests, and under conditions of temperature rise, ventilation, etc., as agreed on by the manufacturer and the purchaser, except as noted in (4) above, with respect to one-hour rating.

(6) The tractive force and the speed shall be determined by the formula:

$$\text{Tractive force} = \frac{T \times G \times 24}{d \times P} \times 0.97$$

unless test data are available, as noted above.

$$\text{Miles per hour} = \frac{S \times P \times d}{336.1 \times G}$$

Where: T = Motor shaft torque in pounds at one-foot radius.
G = Number of gear teeth (if used).
P = Number of pinion teeth (if used).
d = Driver diameter in inches.
S = Revolutions per minute of motor.

(7a) The maximum start rating of the locomotive shall be at the maximum torque which can be exerted by the motors with any combination of connections, and the maximum speed which can be attained with this combination at maximum torque.

(7b) If the tractive force derived as in (7a) is greater than 25 per cent of the total weight on drivers, then the tractive force shall be taken as 25 per cent of the total weight on drivers, and the speed shall be the maximum attainable at such tractive force, with any combination of motor connections.

(8) The one-hour rating of the locomotive shall be determined from the one-hour rating of the motors. When several field combinations are provided for d. c. motors, the combination used shall be indicated.

(9) The continuous rating of the locomotive shall be determined from the continuous rating of the motors. When several field combinations are provided for d. c. motors, the combination used shall be indicated.

Regenerative Braking of Heavy Tonnage Trains on Descending Grades with Electric Locomotives

Regenerative braking on electric locomotives might be said to derive its name from the fact that electric motors, when driven by force of gravity acting upon the train while descending a grade, reverse their function as motors and become generators; changing from a machine receiving electric energy from the power system to overcome the force of gravity acting upon the train when ascending a grade, to a machine generating energy when descending the grade, the energy so regenerated entering

the distribution system and becoming available for utilization by other trains. The resistance of the electric motors in the locomotive in regenerating energy through force of gravity acting upon descending trains forms efficient braking.

Regenerative braking is efficient and safe, but in no case can it be considered as a substitute for air brakes. It can and does supplement air braking, and in many cases eliminates the necessity of the use of air brakes for control of the speed of a locomotive.

Adhesion in regenerative braking might be said to be the controlling factor in certain locomotives, and in any case it is the limiting factor. Care must be taken that the regenerative load on each traction motor is maintained as uniformly as possible, so equalizing the load on each motor and obtaining the maximum results from the locomotive.

Of the various types of motor equipment used on electric locomotives which can provide for regenerative braking are: Alternating current induction motors. Direct current series motors. Single phase alternating motors. Direct current motors and motor generator sets.

Following this section of the report the four methods of obtaining regenerative braking are described. The report continues with a summation of results obtained with regenerative braking as follows:

Regenerative Braking on the Milwaukee

The advantages derived from regeneration on a profile such as that of the electrified divisions of the C. M., St. P. & P. R. R. (see print attached) are important. They include the following:

1. *Saving in Electric Energy.* All the locomotives are equipped with kilowatt-hour meters. These, on the passenger locomotives, register separately the kilowatt-hour motored and regenerated. On the freight locomotives only the net is registered, but readings are taken at such points along the line as enable a fairly accurate separation between motored and regenerated kw. hr. to be made. The kw. hr. meters are in all cases connected into the line rather than the regenerating armature circuit, so that the readings do not include the kw. hr. regenerated and supplied to auxiliaries, including 3000-volt air compressors, motor generator, heater, etc.

The metered regenerated energy flows over the trolley to motoring locomotives, or through adjacent substations over the railroad 100,000 volt transmission line to other substations, or into the power supply system. Payment for power is made on basis of the net kw. hr.

The total kw. hr. saved by regeneration represents a saving in energy for the year of over $80,000.

2. *Saving in Brake Shoe and Other Equipment Wear.* This wear is a result not only of the movement of the car over the electrified divisions, but, in the case of freight cars, even over other railroads. This fact makes it impossible even to estimate the saving in the "other equipment wear," though this saving is clearly indicated by the relative quipment failure records of the original steam and present electrical operation, respectively, and by the much smoother descent of the mountain grades under the latter operation.

With regard to saving in brake shoe wear, it is not practicable in our case to determine this directly by weight or dimension measurements of shoes, so that we have had to estimate it on basis of the reduction of the brake shoe energy dissipation causing the wear. The unit is generally expressed in terms of pounds wear per one hundred million foot pounds of energy dissipated and will vary greatly with the conditions of brake application, e. g., speed, shoe pressure, duration, application, temperature attained, material of wheels and shoes, and weather conditions. The conditions applying in the case of descent of long mountain grades where continuous application is necessary and high temperatures are reached are particularly unfavorable, and data as to wear factor under these conditions have been difficult to secure. In one case, however, the situation was favorable for securing accurate information. It involved heavy traffic on a grade of 2 per cent average, seventeen miles long, covered in about one hour, with one stop of about ten minutes. Steel wheels and Diamond S brake shoes were used, each shoe dissipating about 343,000 ft. lb. per minute. The wear was about 1.36 lb. per 108 ft. lb. energy dissipated. This factor, as an illustration, applied to the reduction of energy dissipation secured on the Milwaukee by regeneration would mean for steel wheels and Diamond S shoes a saving of some $78,000.00 per year. A factor of 1.00 lb. Diamond S shoes for passenger service, and cast iron shoes for wheels for freight service would make the saving about $45,000.00, this in addition to whatever saving may result from elimination of other wear and tear of wheels, brake rigging, etc., as already referred to.

3. *Increased Safety.* Due to the duplicate braking provision.

4. *Increased Schedule Speeds.* No stops are necessary during descent of mountain grades to allow cooling of freight car wheels. Greater speeds are permissible, as the speed is automatically maintained approximately constant, wheels and brakes are cool, and, therefore, available braking power, when needed, at maximum.

5. *Greater Comfort to Passengers.* Due to elmination of the jerks and jars caused by brake application. This is a very noticeable feature and elicits much favorable comment from passengers.

Regenerative Braking on the Virginian

On the Virginian Railway all the electric locomotives are regenerative, and twelve months' operation (1927) over the whole electrified division demonstrated that regeneration was 9.1 per cent of the total power used for motoring, as taken from the watt-hour meters on the locomotives. The watt-hour meters on the locomotives, being across the line, register the total input to the locomotives when motoring, but when regenerating register the output less that used by the auxiliaries.

During 1927, 107,866,440 kilowatt-hours were supplied to the transmission lines for traction purposes, this figure being the motoring energy as measured on the locomotives less 9,837,000 kilowatt-hours regenerated, also measured on the locomotive, but with the pro-rated losses added.

The following extracts from Part 4 of the Virginian Electrification, Cir. No. DV-588, of May 21, 1928, of the Electric Rolling Stock Committee, which refer to regeneration on a test run, are thought to be of interest.

An important feature of the savings incident to electric operation is evidenced in equipment. The 120-ton capacity cars used on the Virginian Railway do not leave the company's lines, and it has been demonstrated that at least 100 per cent more life is obtained from brake shoes than was previously obtained under steam operation. This is accounted for by regenerative braking. It is common practice on eastbound trips not to apply train brakes during the 118-mile run from Clark's Gap to Roanoke, in which two ascending grades eleven miles and nine miles long, both of approximately 1.5 per cent, are negotiated. In fact, the brakes are only regularly applied once during the 131.2-mile run from Elmore to Roanoke. This also has its effect on car wheels; slid flat wheels on all classes of equipment operating through this division now occurring very rarely.

Tables, charts and diagrams are included with this part of the report to show operating conditions and types of equipment used. There is also a report of a typical run made by a Virginian train showing how regeneration is used over the profile.

Heating Appartus for Electric Locomotives Hauling Through Passenger Equipment and Heating of Electrically Propelled M. U. Cars in Suburban Service

With the adoption of electric traction for main line and suburban service of railroads, one of the most troublesome problems which has had to be solved is the heating of the equipment, particularly the heating of the through passenger cars. The heating of multiple unit cars has not presented as much difficulty, as these cars, being built for electric operation, are almost without exception designed and built for electric heating. The problem as it concerns the through passenger equipment, however, is not so simple.

Heating of Through Passenger Cars

The heating of passenger cars electrically, if this were practical, would probably be more efficient than heating by any other method. One of the most serious difficulties, however, would be in the application of electric heaters to cars which also require steam heat, particularly to cars already equipped with steam pipes, and unless the cars were specially designed for the duplicate heating systems when built, the installation of electric heaters would be difficult and expensive.

Under present conditions, with the limited amount of electrified territory (as a rule, only one or two divisions of the railroad system) and the extensive amount of interchange service between the electrified territory and the steam territory, the cost of installation of electric heaters in all passenger cars, even if space were available in addition to the steam heat coils, would be very high. Interchange of cars with other railroads would present still further complications.

Several means of heating of passenger cars on electrified railroads have been tried abroad, such as:

1. Fuel-fired steam boiler in electric locomotive;
2. Fuel-fired steam boiler in baggage car;
3. Fuel-fired boiler in special steam heat trailer;
4. Electrode type of electric steam boiler;
5. Resistance type of electric steam boiler;
6. Electric energy direct from locomotive.

The tendency abroad seems to be toward either the use of the fuel-fired boiler in the special heater trailer, or direct electric heating of cars by means of bus line energized from the electric locomotive with electric heaters in the cars. In general, the heater

trailers are being used during the transition period until all coaches on the electrified divisions are equipped with electric heaters. When this work is completed, these cars will then be suitable for either electric or steam heating. Sweden, Germany, Austria and Switzerland will within a few years have all cars equipped for electric heat and be standard for interchange.

Electric Heating

Aside from the high cost of installing the electric heating equipment on passenger cars, the advantages to be obtained from this direct electric heating are: easy regulation of the heat either in the cars or in the locomotive, uniform heating throughout the train, no freezing up of train line pipes or hose, absence of escaping steam from steam traps, leaky hose connections, lower maintenance cost, etc.

For the a. c. installations abroad voltages of 800 to 1200 are generally used for electric heating. In this country studies have been made as to the possibility of using a heating voltage of 3000 for through passenger cars, anticipating that d. c. electrification will be mainly at the latter voltage and it will always be possible to use the same voltage for a. c. operation by providing a suitable tap on the main transformer in the electric locomotive, provision for a special secondary winding in the transformer for heating, or a separate heating transformer.

Some attempts have been made abroad in connection with a. c. electrification to use existing steam pipes in the coaches directly as heating resistances. This has not gotten beyond the experimental stage. It involves the passing of low voltage current through the pipes themselves and necessitates a separate transformer in each car for stepping down the voltage from that of the heater bus line to about 10 volts.

Transformers on a. c. locomotives abroad used for electric heating of trains have been built to deliver continuously 400 kw. at 1000 volts, or a maximum for short periods of about 500 kw. at 1200 volts for quick heating of trains. The heating circuit is equipped with oil switch provided with overload protection.

Tests made abroad indicate that European passenger coaches require about 8.6 watts per cubic foot for heating, or a total per car of between 35 and 40 kw. American passenger coaches, being of more nearly all-steel construction and having less wood interior finish, require more heat, and this might require a maximum of 50 kw. during very cold weather, and with a twelve or thirteen car train would require around 600 kw. for heating purposes.

For direct current installations abroad, where electric heaters are used in the passenger coaches, the heater voltage has been 1500, or the same as that of the trolley.

For both the a. c. and d. c. installations suitable coupling devices of the plug and socket type between cars have been developed to handle a maximum current of about 400 amperes. Two couplings are installed at each end of each car, one set being in use at a time, the other set being reserved. These couplings, when used on heater circuits of 1200 volts a. c. or 1500 volts d. c. must be convenient, simple and safe. This requires that all live parts be enclosed and that the external parts be grounded in such a way that employes cannot sustain shocks by coming in contact with them. Provision has to be made also for automatically opening the heating circuit by means of auxiliary contacts in the jumper head and receptacle which open on the first movement required to disconnect the jumper, and through a control wire to the locomotive will open the circuit breaker supplying power to the bus line.

Transformer plants mounted on flat cars have been developed and used abroad also for terminal heating of cars preliminary to cars being made up in trains and electric locomotives attached.

Although, as stated, studies have been made in this country of the possibility of electric heating of through passenger cars, looking to the future when the majority of such cars may be operated in electrified territory, the only installation in operation at the present time is on the Butte, Anaconda & Pacific Railroad, which operates between Butte and Anaconda in Montana, where the passenger cars are heated by electric heaters with 2400-volt current from the electric locomotive.

Steam Heating

Steam heat trailers are in general use abroad on electrified railroads for the purpose of heating passenger cars.

In Germany steam-heat trailers using coal-fired boilers are in use. There is, however, a regular program for installing electric heaters in passenger cars so that heating trailers will eventually not be needed.

In Switzerland steam boilers heated by electricity were first tried, but the amount of electric energy used was found to be three times as great as for direct electric heating, and this method was not developed further.

In Italy heating of electric trains is generally by means of coal-fired boilers in steam heat trailers, although the latest type of three-phase passenger locomotive uses an oil-fired boiler in the locomotive similar to the present practice in the United State.

Heater trailers are also customary in France, where the electrification is at 1500 volts d. c.

In the United States at the present time through passenger equipment on the electrified sections of the C. M., St. P. & P. R. R.; the Great Northern R. R., New York Central R. R., and the N. Y., N. H. & H. R. R. is heated by steam. The Great Northern R. R. uses steam heat trailers and has no boilers installed in the electric locomotives.

All electric passenger locomotives of the C., M., St. P. & P. R. R., the New York Central R. R., and the N. Y., N. H. & H. R. R. have steam heat boilers installed in the locomotive cab, and the N. Y., N. H. & H. also have ten steam trailers which can be attached to A. C. freight locomotives to permit the use of these locomotives in passenger service on peak days during the winter months and furnish steam heat to the train.

A brief description of the heating equipment on these various electric locomotives and steam heat trailers is as follows:

1. *C., M., St. P. & P.*—When this electrification was being planned, careful consideration was given to the matter of the relative advantages of incorporating respectively train heating boiler within the electric locomotive itself and incorporating this heating apparatus in a separate trailer hauled by the electric locomotive along with the cars. The former method was finally adopted, as it appeared to be the more economical, one of the advantages being that the added weight of the heating apparatus over the locomotive drivers was available for traction purposes.

The locomotives originally and temporarily used on the electrification for passenger service were of the same type as the present freight locomotive and each equipped, together with six freight locomotives for emergency purposes, with two vertical type boilers, each capable of delivering to the train line, at 70 lb. pressure, 1,450 lb. of steam per hour, or, when forced, 2,050 lb. Each half unit of the locomotive was equipped with one of these boilers and a water storage tank of approximately 14,000 lb. and an oil storage capacity of approximately 250 gallons. Each boiler had a total heating surface of approximately 458 square feet and was equipped with 1,356 one-half inch copper tubes.

These boilers required, under the conditions of service on the C., M., St. P. & P., excessive attention and maintenance, and were removed from the locomotives when the latter were regeared for freight service and new locomotives for straight passenger service purchased. The new locomotives were equipped with boilers designed by the motive power department of the railroad and have given very satisfactory service ever since their installation. Fifteen passenger locomotives are in service with this type of boiler installation.

The characteristics of this steam heating equipment are as follows:

Heating Boiler

Type—Vertical fire tube.
Dimensions—100 in. high by 73 in. outside diameter.
Weight—Dry, 10,150 lb.; wet, 15,150 lb.
Heating surface—Total, 623.8 sq. ft.
Water evaporation from and at 212 deg. F. per hour; Normal, 2150 lb.; maximum, 4,000 lb.
Oil required per hour—Normal, 161 lb.; maximum, 300 lb.
Pounds water evaporated per lb. of oil—13.3.

Water storage	Gallons	Lb.
Boiler	600	5,000
Tanks	3,588	29,750
Total	4,188	34,750
Oil storage	750	6,000

Auxiliaries:
Boiler feed pump: Marsh Type E 5 in. by 3 in. by 6 in. simplex; weight, 320 lb.; capacity 600 gallons per hour.
Oil Pump: Blake Knowles, 3 in by 2 in. by 3 in. Duplex; weight, 125 lb.; capacity, 280 gallons per hour.
Blower: 2,650 cu. ft. at 2 in. max. 1,800 r.p.m. 1,800 cu. ft. at 1 in. normal.

2. *Great Northern* has a district where 75 miles are operated by electric locomotives and they have five special so-called "heater cars." These cars are approximately 40 ft. long and are attached behind the electric locomotive at the head end of the train. In each of these "heater cars" is installed a boiler, three water tanks, one oil tank, etc., for generating steam for the heating of the train.

The operation of the boiler is fully automatic, steam pressure governing the supply of water and the turning off and on of fuel oil to the boiler, so that constant pressure can be obtained with very little attention.

These "heater cars" have been operating for the last two years and are reported as working out very well.

General information relative to these "heater cars" is as follows:

Weight	161,400 lb. (equipped)
Length over coupler faces	43 ft.—8⅛ in.
Length over framing	40 ft.—0 in.
Width over framing	9 ft. —11⅞ in.

Width inside	9 ft.—4¼ in.
Length inside	39 ft.—4⅛ in.
Truck center	26 ft.—0 in.
Wheel base, truck	8 ft.—0 in.
Wheel base, total	34 ft.—0 in.
Wheels, rolled steel, dia	36½ in.
Journals, size	6 in. x 11 in.
Kind of truck	Commonwealth C. S.
Air brakes	Cyl. 18 in. by 12 in.
Pop valves	2½ in. Open
Steam gauge	Ashcroft Electric Control 300 lb. Reliance Jr. Low Water Alarm
Boiler	73¼ in. O.D. by 86⅝ in. High
Flues	480—1½ in. dia. by 58¾ in. Long
Oil pump	Warren Sp'l. 3 in. by 2 in. by 3 in.
Water Pump	Warren Sp'l. 4½ in. by 2¾ in. by 4 in.
Boiler pressure	150 lb.
Heating sur,. total	957 sq. ft.
Fuel oil capacity	1,100 gal.
Water capacity	3,570 gal.
Oil pump gov.—Fisher	⅜ in. Angle Type
Feed pump gov.—Fisher	½ in. Angle Type
Inspirator	Hancock No. 25

The boiler is mounted in the center of the heater car and there are three 1190 gallon water tanks and one 1100 gallon oil tank mounted in the four corners. These are square tanks which rest on the car floor. In order to permit of rapid filling the water tanks are connected by a 6 in. line and are filled through a roof connection from water plug spouts. The filling opening is 14 in. by 20 in. The oil and water tanks are equipped with float gauges.

The oil is fed to the burner by a 3 in. by 2 in. by 3 in. two cylinder pump. This pump is controlled by a steam gauge having electric contacts, so that when 150 lb. boiler pressure is reached, the pump is automatically shut off and in the event of low water, oil to the burner is automatically shut off.

The feed water is injected by a 4½ in. by 2¾ in. by 4 in. pump and for emergency a Hancock inspirator is provided. The water level is maintained by a Stets Boiler Feed Regulator.

The lights and battery are handled by a small steam turbo-generator set. Air for combustion for boiler is drawn into the fire box by natural circulation, assisted by steam jet in the stack. A damper is also provided in the stack for draft control. Boiler is rated at 100 h. p. and operates at 150 lb. maximum pressure.

3. The New York, New Haven & Hartford R. R.—Sixty-eight a.c.-d.c. electric passenger locomotives are in service at the present time on the New Haven, each locomotive being equipped with steam heat boiler and water and oil storage tanks. In addition there are the ten steam heat trailer cars, each equipped with boiler, water and oil tanks, these steam heat trailers being used in passenger service during the winter months when trains are hauled by a.c. freight locomotives, as referred to previously.

The first electric passenger locomotive in service in 1907, had steam heat boilers using kerosene oil for fuel, and capable of evaporating about 800 pounds of water per hour. These locomotives were also equipped with bus line for electric heating of passenger cars at 650 volts a.c. and d.c. A few of the wooden coaches intended for use in local service were equipped with electric heaters and bus line in place of the usual steam heat coils, but no further applications were made and later the electric heaters on these passenger coaches were replaced by steam coils and the heater switches and bus line connections removed from the electric locomotives.

The steam heat boilers on the locomotives have passed through several stages of development in the way of increase in size and capacity.

Two sizes of boilers are now in use, the smaller type being installed in the original a.c.-d.c. passenger locomotives, where on account of space limitations the larger type of boiler could not be installed. Boilers on these forty-one a.c-d.c. electric locomotives have a capacity for evaporating 2000 lb. of water per hour. Boilers on the remaining passenger locomotives and the steam heat trailers have a maximum capacity for evaporating 4000 lb. per hour.

General information relative to these steam heat trailers is as follows:

Length over coupler faces	29 ft. 5 in.
Height	12 ft. 6 in.
Width	10 ft.
Length of body	24 ft.
Two 4-wheel trucks having 36 in. dia. wheels.	
Wheel base of truck, 6 ft. 4 in.	
Spacing between center bearings for trucks	14 ft. 6 in.
Light weight of steam heat trailer	72,900 lb.
Weight with oil and water tanks full	89,900 lb.
Oil tank 34 in. inside dia., 8 ft. 6 in. long, capacity	400 gal.
Water tanks (2) 38 in. inside dia., 14 ft. 6 in long, capacity	1,700 gal.

Fuel

The liquid fuel at present in use is known as "Off Color Kerosene" or furnace oil. It is relatively light in body and the heat value is approximately 18800 B.t.u. per lb. This grade of oil has been used for some time. Almost one million gallons of fuel oil are used per year, the night sleeping car trains requiring steam the year round in order to furnish hot water in sleeping cars.

Boiler

The boiler is assembled in the shop as a complete unit ready to go into the locomotive or steam heat trailer. It consists of the following parts: cast-iron base ring including fire brick, burner and burner box, shell and tube assembly, a superheater (a flat spiral for furnishing superheated steam for the burner), a coping and stack to lead existing gases out through the roof of the locomotive cab, lagging and jacket, two safety valves, gauges, control valves, try cocks, and water glass.

Main reservoir air pressure is used for forcing water from the water storage tanks into the boiler, the supply being regulated by hand by globe valve in the water supply line. Try cocks are also conveniently located near boiler for the use of a fireman in determining the amount of water in the water storage tanks.

The boiler is of the vertical fire tube type with water leg and was designed to give maximum capacity in the limited space available. It was also necessary that boiler be capable of attaining its full pressure and steaming capacity quickly on account of operation out of Grand Central Terminal where the fire in the boiler cannot be started until after the locomotive is out of the Park Avenue Tunnel. Full pressure can be obtained starting cold in about ten minutes.

The boiler shell is made up of two courses of open-hearth steel with bottom and top flue sheets and a baffle plate of the same material, the baffle plate being located just below the top flue sheet, the purpose of the baffle being to insure the production of dry steam. The large type boiler has 1,572 copper tubes, ⅝ in. outside diameter, 31 in. long, while the smaller boiler has 864 tubes, ⅝ in. outside diameter, 28 in. long.

For each boiler there is one 2 in. tube in which is located a fusible plug to protect the boiler in case of low water. The boiler shell is set on a cast-iron base ring to which it is bolted. The fire bricks are cemented into this ring to form the firebox. A special set of brick shapes has been developed covering the firebox sides and bottom, and to line the whole firebox on sides and bottom together with the burner chamber requires only seven differently shaped bricks.

Burner

Several types of burners have been tried in the past and experiments are still being made to develop possibility of improvements in this particular device. The burners are hand regulated as to the relative supply of oil and air or steam used for atomization. The oil is fed to the burner by gravity from the tanks located on the roof of the locomotive, although the steam heat trailers have the oil tank located inside of the cab. The amount of air supplied from the main air duct for combustion can be regulated by means of a damper.

Boiler Operation

The burner is started by using compressed air for atomization of the oil until sufficient steam pressure (70 lb.) is available for operation by steam. The maximum boiler pressure carried in service is around 95 lb., two safety valves being provided, one set at 98 lb. and the other at 103 lb. Three gauges are mounted on each boiler, one showing the boiler steam pressure, the second the steam or air pressure to the burner and the third showing train line steam pressure.

A brief description of the two types of boilers used is as follows:

	Large boiler	Small boiler
1. Number of locomotives equipped with boilers	27	41
2. Number of heater trailers equipped with boilers	5	5
3. Type of boiler	Vertical fire tube with water leg	Vertical fire tube with water leg
4. Maximum operating pressure	199 lb.	100 lb.
5. Dimensions	60½ in. dia. 83 in. high	44 in dia. 70 in. high
6. Number of tubes	1572	864
7. Diameter of tubes	⅝ in. O. D.	⅝ in. O. D.
8. Material of tubes	No. 17 Dwg. copper	No. 17 Dwg. copper
9. Weight (dry)	6480 lb.	4800 lb.
10. Weight of water in boiler operating condition	1600 lb.	600 lb.
11. Total sq. ft. heating surface	680	347
12. Normal evaporation, lb. water per hour, from and at 212 deg. F	3000	1500
13. Maximum evaporation, lb. water per hour, from and at 212 deg. F	4000	2000
14. Lb. of oil used per hour, normal	250	125
15. Lb. of oil used per hour, max	350	175
16. Water storage capacity, gal	816	572
17. Oil storage capacity, gal	200	146

4. *New York Central Railroad.*—A number of experimental electric boilers were tried out by the New York Central Railroad during the period 1907 to 1914. The first consisted of a single series of 28 flat spiral coils of 30 per cent nickel steel arranged in a vertical cylinder, feed water being supplied by a motor driven pump through insulating rubber hose to bottom coil. This boiler was discarded due to electrolytic troubles and difficulty in obtaining special high resistance alloy tubes free from flaws.

A second electric flash boiler of the same general construction was also tried out and discarded because of the use in it of commercial steel of low resistance, necessitating use of smaller tubes with consequent division of the boiler into several units involving numerous insulated joints, difficult to maintain.

A third electric flash boiler was later built consisting of four sections, each section composed of eight 17 turn spiral coils .675 in. outside diameter and .494 in. inside diameter, seamless mild steel tubing of imported ingots. All the coils in one section were electrically welded together and provided with taper unions of nickled steel on either end. The seamless steel tubing composing a coil was covered with a woven asbestos hose, insulated thereby, one turn from the other. The operation of the motor driven pump supplying water to the boiler was thermostatically controlled. The dimensions of this boiler were as follows: 6 ft. 1 in. high and floor space 3 ft. by 2 ft. The boiler consumed 412 kilowatts at 650 volts and would evaporate water at the rate of 1100 lb. per hour at 100 lb. pressure. Test made indicated that boiler would not comply with the requirements as to capacity and efficiency.

Tests were made also with an electric boiler of the vertical fire tube type, in which the resistance elements were made up of fine wire wound on porcelain tubes. A number of these were connected in series end to end and packed in a brass tube with sand to fill the surrounding space and conduct heat. One of these brass tube units was placed in each of the 2 in. boiler tubes and the annular space between filled with sand. The units were connected in six circuits in parallel across full line voltage.

A general description of this boiler is as follows:

Number of tubes	148
Pressure	110 lb.
Evaporation per hour	800 lb.
Current consumed	460 amp.
Watts per tube	2000
Weights:	
Boiler, without water	6085 lb.
Water tank	625 lb.
Switchboard	450 lb.
Auxiliaries, supports and piping	1400 lb.
Total	8550 lb.

This boiler gave some promise during preliminary tests but was discarded after a service test, because of frequent failure of the heating elements and difficulty in renewing these elments.

Oil Fuel Boilers

The original type of steam heating boiler installed on the early New York Central Electric Locomotives was approximately 22 in. in diameter, and 16 in. high, carrying a pressure of 80 lb. with 130 sq. ft. of heating surface, and capable of evaporating 400 lb. of water per hour.

On account of the increase in number of cars hauled, it was necessary to have a larger boiler. In effecting alterations and improvements, the capacity was raised from 400 to 800 lb. of water evaporation per hour.

On the next lot of locomotives ordered, a newer design was developed which had 266 sq. ft. of heating surface, and a capacity of evaporating 1,600 lb. of water per hour.

As the length of trains increased a still larger boiler was necessary, and a design was furnished which would give 436 sq. ft. of heating surface, with an evaporation of 2,200 lb. of water per hour at 110 lb. pressure.

Still later developments have produced a boiler which is now used on New York Central Electric Locomotives operating into Grand Central Terminal and is also the same type of boiler as used on the Cleveland Union Terminal electric locomotives, a total of 49 electric locomotives so equipped.

The following is a general description of the boiler and heating equipment:

1. Type of boiler—Oil fired vertical fire tube with water leg, superheater and preheating coil.
2. Maximum operating pressure—120 lb.
3. Dimensions—Diameter over shell 3 ft. 10 in., over lagging 4 ft. 5 in., max. (over fire box and water leg flanges) 4 ft. 10½ in.; height, over all 7 ft. 8⅜ in.
4. Number of tubes—diameter—mat'l—1250—¾ in.,—Copper; length 36 in.
5. Weight (dry)—Boiler 6930 lb., comb. oil and water tank 3700 lb.
6. Weight of water in boiler, operating condition, 1,050 lb. (to middle gage cock).
7. Total sq. ft. heating surface—636.
8. Normal evaporation, lbs. of water per hour from and at 212 deg. F. —3090 lb.
9. Max. evaporation, lb. of water per hour from and at 212 deg. F. 5390 lb.
10. Lb. of oil used per hour—normal, 254.
11. Lb. of oil used per hour—max., 482.
12. Water storage capacity—lb., gal.—7100 lb. 855 gal. (including water in boiler).
13. Oil storage capacity—lb., gal., 732 lb., 102 gal.
14. Type of burner—Duck bill, N. Y. Central design.
15. Source of supply of air for forced combustion—Turbo-blower.

The burner used for these boilers consists of a pair of flattened pipes clamped together with the upper one containing oil and the lower one containing steam. The openings are approximately 1¼ in. wide. The height of the openings for oil are 1/32 in. and for the steam 1/32 in.

The firebox sides for the boiler are lined with fire brick moulded to conform to the contour of the firebox and the bottom is also similarly lined.

The boiler tubes are arranged vertically and are extended into the top and bottom tube sheets. In the early boilers steel tubes were used but were abandoned on account of corrosion, copper tubes being substituted. On top of the boiler section is a sheet iron smoke box in which is installed the superheater and preheating coil.

The combination storage tank for water and oil is located in the cab of the locomotive in the end opposite the boiler. A water level in the boiler is maintained at approximately half gage glass height, the supply from the storage tank by means of air pressure being hand regulated. Fuel supply is by gravity from storage tank at the top of the water storage tank. Fuel supply, atomization and draft are regulated by hand. The water and oil storage tanks are filled through air hose coupling connections fitted to filling pipes at each side of the locomotive.

The latter part of this section of the report describes in some detail, the different methods employed in Europe and the United States for electrical heating of multiple-unit cars.

Electric Locomotives Placed in Service for the Year Ending June, 1930

Every year the committee publishes a tabulation showing number and types of electric locomotives placed in service during the year.

The tabulation for the large electrified railroads in the United States covers electric locomotives placed in service since the report last year. The tabulation for foreign electric locomotives, in some instances, covers locomotives placed in service prior to last year's report. The information in connection with foreign electric locomotives is supplied to committee by representatives of the electrical companies, the data being secured by their foreign representatives, and they are not always able to secure complete data. Therefore, it is not to be assumed that the tabulation of the foreign electric locomotives is complete.

The data referred to is shown on a folded insert. Comments concerning electric locomotive development are also included in the report as follows:

The improvement and growth of the steam locomotive has made it more competitive with electric power. In fact, a few years ago the traffic requirements on certain profiles indicated that electrification would be necessary in order to meet the growing demand. However, it has not been necessary to resort to electrification, as the improved steam locomotive is still meeting the requirements efficiently. Just how long the steam locomotive will continue to meet these requirements is problematical.

The electric locomotive has also been undergoing developments that have increased its possibilities in both speed and power. Electrical equipment is now available in terms of speed and horsepower per driving axle that exceeds anything that might be hoped for with the steam locomotive.

The Pennsylvania Railroad has an extensive electrification program under way which contemplates complete electrification between New York and Washington, and westward to the vicinity of Harrisburg. This program will include electrification of all services—passenger, freight and switching. The through passenger service will be handled by high-speed express locomotives; freight service with locomotives of moderate power, operated singly or with two or three in multiple as service conditions require; and the suburban service with high-speed multiple unit cars.

Two types of passenger locomotives are proposed, one with two driving axles, and one with three driving axles. Each driving axle will be powered with a twin motor of over 1,000 hp. The freight locomotives will have four driving axles, each with a single geared motor of somewhat over 500 hp.

There are now in the United States twenty-three electrified sections on eighteen steam railroads, aggregating 1,700 route miles and 4,000 track miles, operating nearly 600 locomotives and more than 2,000 multiple unit cars. However, these electrification sections were installed to meet special requirements or local conditions, such as heavy grades, tunnels, legislative requirements,

or avoid building second track, etc. The Pennsylvania Railroad's projected program of electrification is the most complete and extensive electrification ever undertaken in this country.

The Cleveland Union Terminal has just completed its electrification between Collinwood and Lindale, using 3,000-volt direct current locomotives. Twenty-two locomotives have been delivered and in all probability electric service will be put in operation in the late spring.

The Lackawanna Railroad is at the present time installing electrification for suburban passenger service in the vicinity of New York, and the Reading Company is electrifying for a similar service at Philadelphia. These installations may later be extended to handle freight and through passenger service.

The committee wishes to acknowledge the helpful co-operation of the Westinghouse Electric & Manufacturing Company, General Electric Company, and American Brown Boveri Company, Inc., represented by F. H. Shepard, A. H. Armstrong, and William Arthur, respectively, who worked with the committee during the year.

The report is signed by: R. G. Henley (chairman), superintendent motive power, Norfolk & Western; A. L. Ralston, mechanical superintendent, New York, New Haven & Hartford; J. H. Davis, chief engineer electric traction, Baltimore & Ohio; J. V. B. Duer, electrical engineer, Pennsylvania; R. Beeuwkes, electrical engineer, Chicago, Milwaukee, St. Paul & Pacific; H. A. Currie, electrical engineer, New York Central; E. W. Jansen, electrical engineer, Illinois Central; J. W. Sasser, superintend.nt motive power, Virginian; L. C. Winship, electrical engineer, Boston & Maine.

(On motion of Mr. Purcell the report was accepted with thanks and the committee continued.)

Moving Pictures of Power-Brake Tests

Moving pictures relating to the development of the power brake investigation and showing the operation of the test train which is being operated over the Siskiyou line of the Southern Pacific, were shown before the Mechanical Division at last Friday's session, by H. A. Johnson, director of research, in charge of the tests. Mr. Johnson showed these pictures again yesterday for the benefit of those members not present last week. In presenting the pictures, Mr. Johnson spoke as follows:

H. A. Johnson (A. R. A.): The air brake investigation was started in 1922 upon the order of the Interstate Commerce Commission. During that year extensive hearings were held in Washington and a great deal of testimony and information taken.

Following the first taking of testimony tests were made on the Norfolk & Western, after which additional information was taken, and in July, 1924, the Commission issued a preliminary report. That report stated that improvements in power brakes were essential and must be made. A month or two later the Bureau of Safety of the Commission published a tentative report and specifications covering the requirements which, in their opinion, a suitable power brake should meet. To comply with this specification would require the installation of a complete new air-brake system on practically all of the freight cars in the country.

The expense of such a change being so great, and there being a difference of opinion as to whether such an expense was necessary, the American Railway Association agreed with the Interstate Commerce Commission to make a thorough and unbiased investigation of the entire matter to determine what improvements, if any, were necessary or desirable. The railroads placed the responsibility of making this investigation upon the Committee on Safety Appliances of the Mechanical Division, which committee outlined the general procedure. It was to consist of rack tests on the Association's test rack located at Purdue University, to be followed, if these rack tests showed it desirable, by road tests in actual service.

The rack tests were started in the latter part of 1925 and continued until the early part of 1929. The results of the rack tests showed it was desirable to make road tests, and these tests were started on the Southern Pacific System August 1 of last year, and are still in progress.

It is too early at this time to give you any results or any final information. All the members of the Association probably will not have the opportunity to witness those tests, so it was thought desirable to prepare some moving pictures to you and give you a better understanding of how the work is being carried on. These pictures were taken by the photographic department of the Atchison, Topeka & Santa Fe through the courtesy of John Purcell.

It was also thought desirable at this convention to have an exhibit of the different air brake equipments which are being tested on the Southern Pacific, and that is the exhibit which you see at the rear of the room. The new air brake equipments, the Type FC-5 and the Type FC-3, as shown in this exhibit, are developed for the experimental work. The form and the number of parts is not the commercial form. They were developed for the purpose of making the installation on the test rack as simple as possible, and converting from one equipment to the other by the elimination of certain functions and parts. Whatever is finally decided as to the additional functions required, of course, will be put in commercial form later on.

Vice Chairman Ayers: This concludes the meeting for today until tomorrow morning at 9:30. We are indebted to Mr. Purcell and the Santa Fe for the pictures and I am sure it was interesting to all of us to see what the safety appliance committee, Mr. Johnson and his associates, are doing with the air brake tests which is a highly important development going on at the present time.

(The meeting then adjourned)

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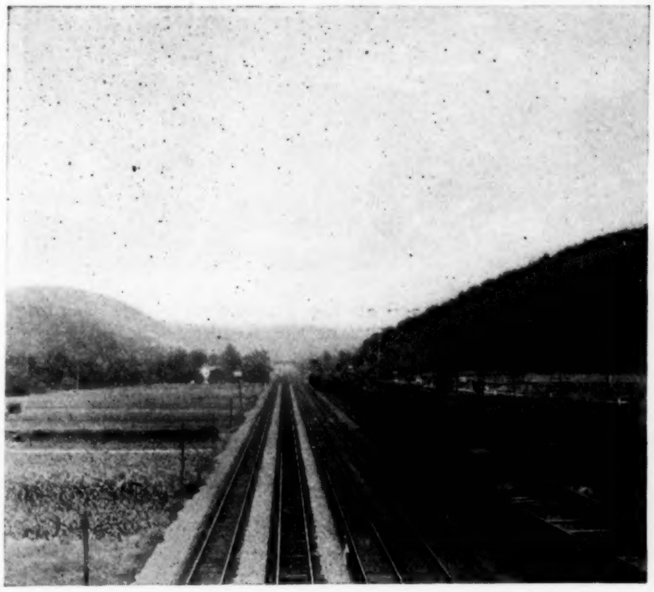

On the Delaware, Lackawanna & Western, near Henryville, Pa.

New Devices

The Robert Bosch Lubricator—A Correction

In the *Railway Age Daily* for June 24, the Robert Bosch high-pressure forced feed lubricator was referred to in a descriptive article as "The Q & C Bosch". These lubricators are the product of the Robert Bosch Magneto Company, Inc., Long Island City, N. Y., and the Q & C Company is the exclusive railroad distributor.

Locomax Front-End Paint

LOCOMAX, a front-end paint, developed and prepared by the Koppers Research Corporation, Pittsburgh, Pa., and applied for exhibition purposes on the front-end of the Reading 2-10-2 locomotive which is included in the track exhibits, is a bituminous product which produces a satin-like finish similar to that produced by graphite paint. It can be obtained in standard black and standard gray egg-shell finishes in tones ranging from jet black to a light steel gray.

Locomax Paint Displayed on the Front End of the Reading 2-10-2 Type Locomotive at the Reading Terminal

It withstands the intense heat and rapid changes in temperature without deterioration and without loss of protection to the metal and is designed to give two months' service with one application. It can be applied on the hot surfaces without danger of flashing back since it containes an oil with a flash point of 172 deg. F., which is 72 deg. above the 100 deg. F. safety-line specification. Daily wiping with dry waste improves the finish.

Super Galvannealed Sheet Metal

A SHEET metal with a base of special analysis steel, coated by the hot process with spelter and alloys of other metal, is being exhibited by the Superior Sheet Steel Company, Canton, Ohio. This material, which is being introducd into the railroad field, is highly rust resisting, the coating withstands fabrication, and paint and other similar coatings form a bond with the surface of the sheets.

In the process of manufaturing Super Galvannealed the coated sheets are mechanically treated in a heat-treating furnace. This process expands the metal, permitting the amalgamation of the coating with the base metal and permitting the metal to be fabricated without fracture of the coating. In the heat-treating process the salamoniac and other elements essential to the galvanizing process are eliminated. The presence of these elements on the surface of the sheet is the cause of the failure of paint to adhere to an ordinary galvanized surface and their removal leaves a surface to which paint readily and permanently adheres.

The metal has been marketed for the past five years in various fields for refrigerator cabinets, signs, washing machines, etc., and during that period there has been no evidence of any failure. It has been subjected to a salt spray test of 690 hours' duration, after which the material was apparently unaffected. The exhibit of the material includes samples undergoing this test which will be continued for 168 hours, or the duration of the exhibit.

This metal is being introduced in the railroad field for such applications as passenger-car window sash and frames, for ventilators and for roofing on both passenger and freight cars, to which applications it is adapted because of its rust-resisting qualities and its ability to withstand fabrication and to hold coatings of paints, lacquers and baked-on enamels.

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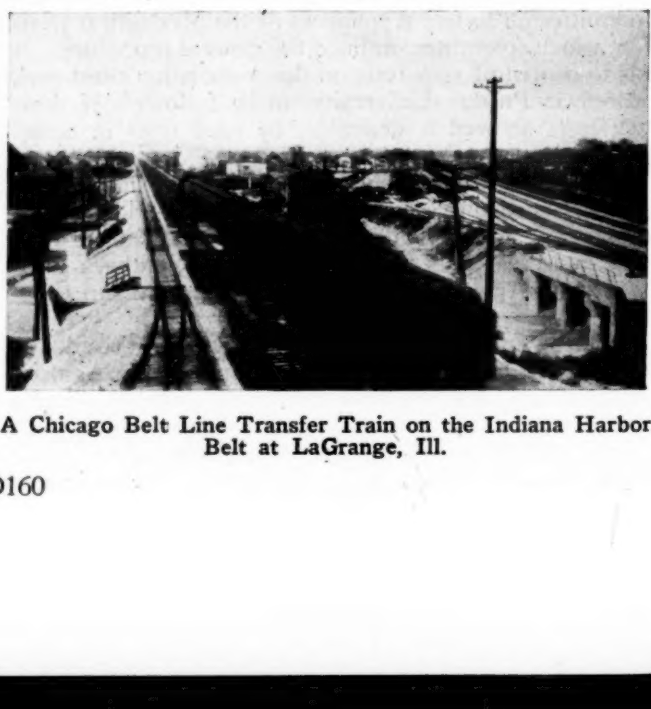

A Chicago Belt Line Transfer Train on the Indiana Harbor Belt at LaGrange, Ill.